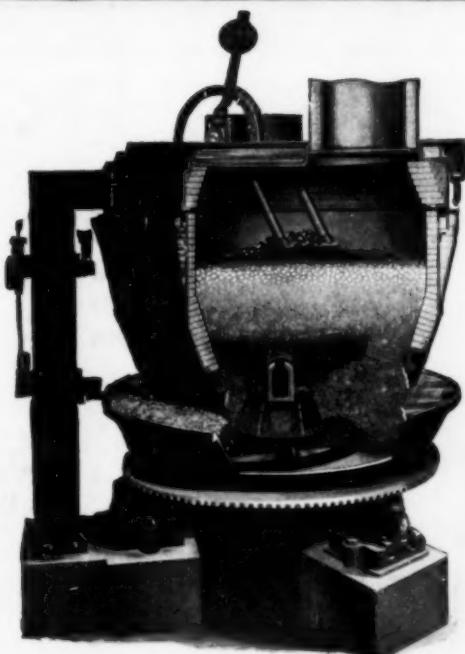


CHEMICAL & METALLURGICAL ENGINEERING

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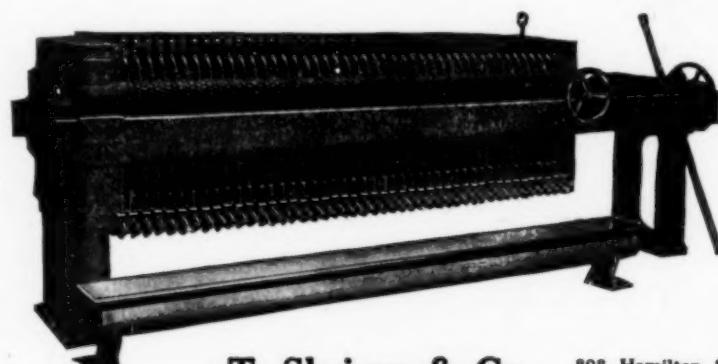
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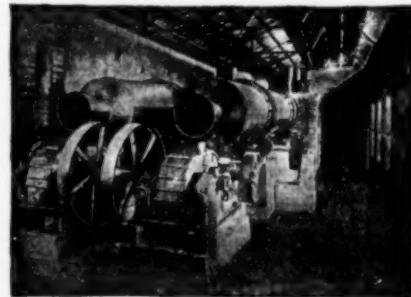
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Number 6

The Report of the British Nitrogen Products Committee

ONE of the revelations of the World War was the unpreparedness of the allied nations in the matter of nitrogen fixation. Not only did the beginning of the war find the principal English-speaking nations without a nitrogen-fixation industry and depending on Chile for sodium nitrate, but the war ended before either Great Britain or the United States had brought to completion their plans for the production of synthetic nitrates on a large scale. Germany alone developed her Haber process from insignificant proportions at the beginning of the war to an industry of great magnitude before hostilities ceased. True, with Germany it was a more vital matter than with the Allies, as the latter could still obtain some supplies of Chilean nitrate. In order to augment this supply Great Britain had, before the end of the war, considered the establishment on a large scale of the calcium cyanamide process, and on a development scale of the synthetic ammonia and ammonia oxidation processes. The United States had practically completed a similar program.

With the end of the war developments ceased abruptly and neither Great Britain nor the United States has made more than nominal progress since that time. As a consequence the plans of either nation are of the greatest importance to the other, reflecting as they do the best possible thought on the subject. The British Nitrogen Products Committee, appointed in June, 1916, to consider the establishment in Great Britain of some of the newer processes for fixing atmospheric nitrogen, has recently published its final report, and while a copy has not yet reached this office, we are enabled to review the salient features of the report from an abstract appearing in a late issue of the *Chemical Age* (London).

The recommendations of the Committee are significant in view of the program actually under way in the United States at the time of the Armistice. Calcium cyanamide is apparently recognized as the most likely fixed-nitrogen product that can be made on a commercial scale without further research or experimentation. The Committee recommends the establishment without further delay of a plant using this process on a scale sufficient to yield 60,000 tons of cyanamide per annum. The synthetic ammonia process and the oxidation of ammonia are recognized as yielding the greatest promise for the future, and the Committee recommends the establishment forthwith of the synthetic process "on a commercial unit scale and its expansion as rapidly as possible" to a production of 10,000 tons of ammonia per annum. Likewise, the ammonia oxidation process should be established on a scale sufficient to yield about 10,000 tons of nitric acid per annum.

With reference to power, the Committee's conclusion

points quite logically to hydro-electric developments as the cheapest source on a large scale. Of more than ordinary interest is the Committee's conclusion that the present state of our knowledge on the application of low-temperature carbonization of coal as a preliminary to power production, in order to conserve ammonia and other byproducts, is not sufficiently encouraging to warrant the establishment of plants on a large scale.

Undoubtedly the development of a nitrogen-fixation industry in Great Britain, as in the United States, is vital to the national welfare. Great Britain's Committee is of the opinion that its development will require the active support of the Government. A similar question confronts the United States, and it will be necessary in the near future for our own Government to decide what its policy will be toward nitrogen-fixation in its relation particularly to the fertilizer industry in peace times. The report of the British Committee undoubtedly will be studied with profit as soon as copies are available for distribution in this country.

Industrial Research And New Technology

UP TO comparatively modern times the progress of industrial development was slow. Industrialists were confined mainly to the results of their own limited observations or to those of their immediate associates, and it was thus only by means of empiricisms, ideas unaided by even approximate theoretical conceptions, that any advancements were made in the industrial arts. There were no scientific or technical publications that carried knowledge to and fro through the isolating factory walls that secluded these men. They toiled alone; passed on their art through apprenticeship and left it practically as they had received it from their master. They were jealous minded, secretive and generally indisposed toward any changes being made in their art.

In recent times the progress of some of the industrial arts, through the aid of research and our present system of scientific co-operation, has been nothing less than revolutionary as well as exemplary for those still continuing to tread around on the same old spot where they started. The modern achievements in mechanics, electricity and chemistry as fruits of research need no elucidation here. But in order to show our readers some actual indication of the scope for the application of research to almost every variety of industry, we publish in this issue a brief exposition of the work now being carried on at the Mellon Institute. A year or two ago the administration of the Institute made an extensive inquiry to determine what expenditures were being made for research in the various industries of this country. Twenty million dollars was decided to be approxi-

mately the amount, one-half of which was expended in industrial laboratory investigations and the remainder on engineering developments.

Compared with other items to be found in our national budget, this research cost seems to have been kept at too conservative a figure, especially when it is considered from the point of view of what the credit column of this account would show if it were possible to assign a monetary figure to it. It is believed that a yearly return of at least \$100,000,000 would not be too optimistic an estimate of it.

Industrial research is performed for gain, and to be properly evaluated should be run on sound business principles. This means that it should be charged for what it receives and credited for what it yields. Its expenditures should be so gaged that maximum gains will be obtained. To accomplish this, executive talent of the first order is required. If this were done, there is no doubt that it would be much more appreciated by the captains of industry, to whom only the balance sheets from their accounting departments are to be taken as navigating guides.

Carbon and Molybdenum

As Producers of Flakes in Steel

PRACTICALLY all the evidence on flakes brought out at last winter's meeting of the American Institute of Mining and Metallurgical Engineers can be harmonized with the hypothesis that aside from deep-seated shrinkage cracks or strain cracks in ingots, the so-called flake—or its first cousin woody structure—in a finished piece is due to the presence of oxidized impurities of extreme tenuity. Several American metallurgists have expressed the opinion that flakes probably would be found in commercial steel of almost any composition if transverse testing would be regularly done, and with but two or three notable exceptions would not subscribe to the suggestion that the chemical specification was of determining weight in causing flakes. The French metallurgist J. J. COHADE, of Le Creusot, is a firm believer in the latter as being a very important factor, and his paper before the fall meeting of the British Iron and Steel Institute cites explicitly his experience that molybdenum or high carbon-nickel analyses engender woody fractures solely by virtue of the chemical composition. Woody structure thus appears in charges much less difficult to work sensibly free of inclusions than similar analyses lower in the objectionable elements but treated to give comparable tensile strengths.

English metallurgists were apparently as chary of accepting this conclusion as are their American brethren. For instance, in the discussion of Mr. COHADE'S paper Sir ROBERT HADFIELD and Dr. W. H. HATFIELD agreed that the quality of steel was largely influenced by the furnace and casting temperature, Dr. WALTER ROSENHAIN seconding them with the statement that high hearth heats and long high annealing will eliminate woody structures. In detail T. M. SERVICE notes that good armor required a high working temperature—and here he agrees with Mr. COHADE—a careful adherence to chemical specification, and a very fluid slag during the boil eventually to exclude solid non-metallic impurities. Steel cast at 1,560 deg. C. would therefore be much better than that cast at the more usual heat of 1,420 deg., while high forging temperature further aided in the production of superfine metal. E. H. SANITER, on the other hand, gave the opinion that woody structure

was due to a state of strain existing in the steel, while W. H. DICKINSON thought that the original structure of the ingot was responsible, and that the effect of invisible inclusions was most important, the latter conclusion being supported by Dr. J. E. STEAD. Dr. GIOLITTI and COSMO JOHNS united in emphasizing the idea that while inclusions were doubtless responsible for defective transverse tests, the result was due not so much to the presence of the inclusion as to its effect on the surrounding metal.

Thus, much dissent was expressed to the hypothesis that carbon, nickel or molybdenum is a flake producer *per se*. Mr. COHADE himself probably aims to emphasize not so much the danger of carbon in steel as the effect chemical composition plays on segregation, since at the outset he quotes the first of four causes of woody structure as "mostly from the presence of non-metallic inclusions," and in the body of his paper he says of defective high-nickel steel that "it appears probable to the author that the improvement due to a lower percentage of carbon is the result of less segregation around the dendritic crystals formed during solidification, owing to the greater speed with which this takes place."

Apparently, in the case of carbon and nickel, segregation is again the culprit, so the difference between the author and his critics is less real than apparent. Perhaps, although Mr. COHADE is silent on this point, molybdenum acts as a litterer or a dispersing agent, as a very antithesis of scavengers or flocculators such as manganese or titanium; and its hesitant acceptance by meticulous tool-steel makers is due to this fact unconsciously rather than to a series of transverse tests.

Bribery of Dyers In Textile Mills

THE Federal Trade Commission gives out the news that complaints have been made against the United Chemical & Color Co., of New York, Andreykovitz & Dunk, Inc., of Philadelphia, the Arkansas Distributing Co., F. Bredt & Co., the New York Color & Chemical Co., the Franklin Import & Export Co., and the Heller & Merz Co., all of New York, alleging as follows: "That the respondents have been giving and offering to give to employees of both their customers and prospective customers, and their competitors' customers and prospective customers, without the knowledge or consent of their employers, sums of money" (and in some cases "and other gratuities") "as an inducement to influence their employers to purchase or contract to purchase from the respondents, dyestuffs, chemicals, etc., or to influence such customers to refrain from dealing or contracting to deal with competitors of respondents."

These are charges and not findings. So far as certain of the parties named are concerned we are convinced that if any efforts at bribery were made it was without the sanction of the men at the head. But that is not the affair of the Federal Trade Commission. Its duty is to try these complaints impartially, and, if it finds still in existence any continuations of the old habit of bribing the dyers, to call down the penalty of the law upon the offenders.

For many years this has been an infernal nuisance to the textile industry. It is a mean, underhanded trick, and its practice was very widespread. The color agent had to deal with the dyer, to teach him to use the dyes, to "make it right with him," and to leave

him satisfied. The easy way is to give him a rebate which is charged to the consumer—and the dyer is used to it. Without doubt a considerable number of these precious crooks declare that everybody else is offering these presents, and of this the salesman is finally persuaded. Bribery was a standard feature of German commercial practice, "and," as an old dyesalter said, "they didn't even know it was wrong. The rest of us did—but we bribed the dyers all the same."

We know of one concern that has laid down the law to its entire force that under no circumstances or provocation shall any kind of so-called "gratuity" be paid, and we understand that a goodly number of others hold to the rule. To break it is to offend against the law and to encourage dishonesty. There is nothing in the practice of the dyer's art to make him less dependable than other men except this German tradition, and if dyers as a class are so poor in spirit that they cannot stand up against it we hope that manufacturers and dealers will be made to find it unprofitable to give in to them. The whole country has a business reputation to make in some things, and to bear in all things, and it will not do to let a lot of hold-over dyers with itching palms jeopardize its fair name.

Maybe the textile industry will see a light some day and induce textile chemists to supervise their tinctorial work instead of working by the rule-of-thumb methods of some boss dyer who learned his trade and his cupidity in secret from some one no better than himself. If a chemist indulges in such practices he is guilty of unprofessional conduct and there is abundant warrant to expel him from any learned society.

Business Men For Exalted Positions

In proportion to one's labour, eminences are gained; and he who seeketh eminence passeth sleepless nights.

Whoso seeketh eminence without labouring for it, loseth his life in search of vanity.

WELL applied, indeed, are the words of the Arabian poet to the conduct of life in these times, and most aptly fitted to the career of the present-day politician. There is a call for men who study and know the factors that influence our economic and industrial life. Business men are needed in administrative government positions from the President down. The most hopeful prospect is HERBERT HOOVER.

Wages and Hours In Steel Industry

THE 10 per cent wage advance to common labor, announced by the United States Steel Corporation as effective February 1, may be readily interpreted as indicating that the Steel Corporation has no present intention of eliminating the twelve-hour shift, which now applies to something like 20 per cent of the total number of men employed in the iron and steel industry. It is easily recognized that were the elimination of the twelve-hour shift feasible in other respects, it would be necessary to compromise matters with the men involved by paying them a larger rate per hour for the smaller number of hours of employment provided, and the time when the employer is disposed to accept a higher labor cost or feels that the workmen require an improvement in their condition is the natural time for such a compromise.

Under the rate for common labor that obtained in

the iron and steel industry from August 1, 1918, to February 1, 1920, 42 cents an hour, and with the "eight-hour basic day" established October 1, 1918, the man who is on duty twelve hours is paid fourteen times the hourly rate, while with the same rate for an eight-hour day he would be paid for eight hours' time, or only 58 per cent as much. Obviously, such a change would make an impossible condition for the man. Under the expiring rate, a man working twelve hours and being paid for fourteen hours' time received \$5.88, making \$11.76 for two men, to complete the twenty-four-hour cycle. A straight 10 per cent wage advance increases this to \$12.94. The same sum distributed to three men, thus leaving the labor cost unchanged, would give \$4.31 to each man, this being 27 per cent decrease in the day's earnings instead of 42 per cent, therefore constituting a long step toward a compromise.

In order to employ three men in place of two an extra man must be found, and the Steel Corporation management was evidently of the opinion that this would be difficult if not impossible, while it is fair also to presume that it was known that the men individually do not wish the change, that as a rule they prefer to work the long hours and receive the correspondingly greater pay. Such conclusions are important, since there is no reason to doubt either that the Steel Corporation desires to be fair with its workmen or that it is very well informed as to labor conditions and the attitude of the men.

The incident furnishes no ground for a conclusion that abolition of the twelve-hour day is to be postponed forever. We are in a transitional condition. There is a shortage of labor in the sense that there are more jobs seeking men than there are men seeking jobs. There is much reason to doubt whether there is a shortage of ability on the part of the workers in the United States, taken as a whole, to do the work that is seeking to be done. Probably the time will come when men individually will be willing to work harder, and then the iron and steel industry may be able to obtain more men.

In another sense there is a transitional condition. The common labor of the iron and steel industry has been very largely foreign born in the past, and the supply of such labor is practically shut off. Eventually men with different ideas as to the length of time they are willing to be on duty will have to be employed to operate the blast furnaces and steel mills. Those men may prefer to work eight hours for eight fourteenths, or ten hours for eleven-fourteenths, as much money as for twelve hours. Were such a time to come the problem would solve itself with no effort by employers.

There is no occasion to fear that at any time in the future there will be a protracted shortage of labor in the iron and steel industry such as would prevent the furnishing of supplies desired by consumers. The amount of labor involved in making a ton of finished rolled steel is so small relative to the industrial value of the steel that it will always be commercially feasible for the iron and steel industry to bid the prices necessary to obtain the labor. A large amount of labor is required in the consumption or employment of steel. In case of competition for labor, the typical consumer of steel is more likely to find his own labor cost prohibitive than to find the cost of the steel prohibitive, if enhanced only by the necessary increase in the labor cost of producing that steel. Market conditions never remain unchanged long enough to enable the economic law to work out the result.

Readers' Views and Comments

The Eventual Retort Plant for the Distillation of Oil Shales

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent article entitled "The Eventual Retort Plant for the Distillation of Oil Shales," by Louis Simpson (CHEM. & MET. ENG., vol. 22, p. 71), there appears the following staggering statements:

"It is, however, now known that to obtain the recovery of the maximum yield of nitrogen as ammonia gas, every particle of the spent shale should be exposed to a temperature of 1,125 deg. C., or 2,060 deg. F. It is also known that a decrease of comparatively few degrees of temperature will result in a very large and entirely disproportionate decrease in the yield, while an increase in temperature over the critical temperature increases the yield only slightly."

I seriously doubt the veracity of those assertions. According to Ramsay and Young, ammonia commences to decompose into its elements at about 500 deg. C. under the most favorable circumstances, and on passing the gas through a porcelain or iron tube the decomposition is complete before 800 deg. C. is reached, the actual temperature being about 780 deg. C. The temperature of 1,125 deg. C., mentioned by Simpson as the most favorable for a maximum ammonia yield, would disintegrate the NH₃ molecule with great violence, and it would be impossible for the elements (N₂ and H₂) to recombine to any appreciable extent under the conditions he assumes, because of the peculiar physical nature of the equilibrium represented by the equation



This reaction is exothermic, therefore a high temperature will inevitably shift the equilibrium to the left, and the absence of pressure aids this decomposition, because the formation of ammonia is attended by a contraction in volume, while its decomposition proceeds with an increase in volume. This is merely an application of the principle of Le Chatelier. (See also F. Haber, *Zeit. für Etekrochemie*, vol. 16, p. 244.) Even under the most favorable conditions, hydrogen and nitrogen combine to ammonia very slowly, unless the velocity of the reaction is increased by the use of a catalyst. Hence it is self-evident that the physical conditions which Simpson suggests as ideal would play havoc with the ammonia molecule, and make the yield of this product practically zero. ARTHUR J. FRANKS.

Colorado School of Mines,
Golden, Col.

To the Editor of Chemical & Metallurgical Engineering

SIR:—The reaction cited by A. J. Franks is doubtless correct, so far as the decomposition of pure ammonia is concerned, but the problem, in the case criticized, is different and involves the claimed decomposition of ammonia, diluted in steam and other gases.

Dowson claims that at low temperatures only a small percentage of steam decomposes, and it is only with the decomposition of steam that the formation of ammonia, when treating oil shales, becomes possible.

The ammonia produced by the decomposition of steam, in the presence of nitrogen, does not remain subjected to the high temperatures needed to secure the decomposition of the steam used, the combination tak-

ing effect in the presence of an excess of steam and of other gases.

Since the war, German chemical literature teems with information as to the influence of steam and other gases upon this and similar combinations of gases.

Were Mr. Franks' ideas correct in practice, it would be possible to secure a maximum recovery of ammonia only through the use of a very great excess of steam. The Scotch practice demonstrates, and demonstration is safer to follow than any theory, which, as in this case, may be incorrectly applied, that there is something not sound in Mr. Franks' contention.

Whether the 1,125 deg. C., mentioned by me, be too high a temperature or not is really of small consequence at this moment. It is known that the Scotch retort could not stand up against the high temperature required for a maximum yield of ammonia, so it was necessary to devise a plant that would stand up. If my plant will stand up against 1,125 deg. C., and a temperature much lower than 1,125 deg. C. is required, so much the better. The chemical reaction employed is not different from that used in Scotland for many years, with more or less success, so that a plant that will satisfactorily endure the highest temperatures used in the Scotch retort, and even higher, and which is so designed that the heat can be regulated and also applied more regularly and intimately, must of a necessity be an improvement.

LOUIS SIMPSON.

Ottawa, Canada.

Resistance of Absorption Tower Packing to Gas Flow

To the Editor of Chemical & Metallurgical Engineering

SIR:—In my paper on "Resistance of Absorption Tower Packing to Gas Flow," printed in your number of Dec. 24-31, an error occurs on page 766.

You have printed formulas 1 and 2 as:

$$p = \frac{ks^2}{v}$$

and $s = a$

respectively, whereas they should read:

$$p = ks^2$$

$$\text{and } s = \frac{v}{a}$$

Wilmington, Del.

FRED C. ZEISBERG.

Cellulose Symposium

To the Editor of Chemical & Metallurgical Engineering

SIR:—Will you let me make the correction of the little slip made on page 708, vol. 21, of CHEMICAL & METALLURGICAL ENGINEERING? In this you report me as saying that "the art of hydration of paper making fiber has not yet been discovered." Of course the art of hydration by mechanical means has been known for a long time, but I was endeavoring to point out the desirability of substituting the use of chemicals to replace part of the long mechanical treatment now necessary in the manufacture of such papers as grease-proof and glassine. My conclusion was that although many suggestions have been made, no one has succeeded in making the chemical hydration of wood pulps a commercial success.

W. P. COHOE.

New York, N. Y.

Hoover for President

To the Editor of Chemical & Metallurgical Engineering

SIR:—In accordance with the instructions of the Joint Council of Engineers of San Francisco, I have the honor to transmit to you copy of a resolution hereto attached, favoring the "Hoover for President" movement. It is the intention of the Joint Council, in forwarding this letter and its accompanying resolution to engineering organizations throughout the United States, to arouse engineers generally to the importance of having for our next Chief Executive of the nation a man of proved administrative ability, unquestioned integrity and absolutely free from partisan politics.

Engineers can well appreciate the exceptional fitness of Mr. Hoover for President, and through their organizations are in a position to form the nucleus of a non-partisan movement to improve materially the running of the biggest business organization in the world—the Government of the United States. C. H. SNYDER,

Secretary Joint Council.

The following is the resolution unanimously adopted by the Joint Council of Engineers of San Francisco, Jan. 13, 1920:

Whereas there is at this time a strong and widespread sentiment for Herbert C. Hoover for President of the United States as an independent candidate, free from political deals and pre-election pledges; and

Whereas Mr. Hoover, by his work in Europe, has shown executive and administrative abilities of the highest order, particularly fitting him for handling both the economic problems of reconstruction at home, and our relations with other nations; and

Whereas the Joint Council of Engineers of San Francisco has a patriotic duty to perform at this time, not only as representing engineers, but also as a representative body of American citizens; be it therefore

Resolved, That the Joint Council of Engineers of San Francisco, representing 2,000 engineers in the Bay district, indorses Herbert C. Hoover for President and invites the engineering bodies of the United States to join with it in forming an organization to further Mr. Hoover's election, and in such other activities as will insure the affairs of the nation being handled on an efficiency and non-partisan basis, and be it further

Resolved, That copies of this resolution be sent to all engineering organizations and technical journals throughout the United States, and that such other steps be taken as will further the movement of "Hoover for President."

Spring Meeting of the American Electrochemical Society

Plans for the meeting of the American Electrochemical Society in Boston, April 8, 9 and 10, are maturing rapidly and give promise of an excellent meeting. Joint sessions will be held with the American Institute of Electrical Engineers on the subject of electric-furnace alloys and power for electrochemical purposes. A symposium on the regular program will cover the subject of colloid chemistry. Among the trips already planned is one to the General Electric Co.'s plant at Lynn, to inspect the manufacture of the tungar rectifier and the kenetron tube. Headquarters will be at the Copley Plaza Hotel.

Chemical Warfare Service

No change was made by the Committee on Military Affairs in the Chemical Warfare section of the Army reorganization bill when it was reported to the Senate. The exact language drafted by the sub-committee in providing for a separate Chemical Warfare Service is part of the bill which is now before that body.

A.I.M.E. Annual Meeting

A CIRCULAR has been issued giving the program of the 121st meeting of the American Institute of Mining & Metallurgical Engineers, to be held in New York City, Feb. 16 to 19, 1920. Programs of interest to metallurgists will be held as follows:

Non-Ferrous Metallurgy, Institute of Metals Division, Tuesday, Feb. 17, 10:30 a.m. Papers to be presented: Intercrystalline Brittleness of Lead, by H. S. Rawdon; A Peculiar Type of Intercrystalline Brittleness of Copper, by Henry S. Rawdon and S. C. Langdon; Relationship of Physical and Chemical Properties of Copper, by Frank L. Antisell.

Milling and Smelting Session, Tuesday, Feb. 17, 2 p.m. Papers to be presented: Volatilization in Assaying, by Frederic P. Dewey; Reverberatory Furnace for Treating Converter Slag at Anaconda, by Frederick Laist and H. J. Maguire; Coal Pulverizing Plant at Nevada Consolidated Copper Smelter, by R. E. H. Pomeroy; Milling Plant of the Alaska Gastineau Mining Co., by E. V. Daveler.

Iron and Steel Sessions, Wednesday, Feb. 18, 10 a.m., and 2 p.m. Papers to be presented: Blast-Furnace Flue Dust, by R. W. H. Atcherson; Manufacture of Semi-Steel for Shells, by Frank E. Hall; An Experiment in One-Piece Gun Construction, by P. W. Bridgeman; Tensile Properties of Boiler Plate at Elevated Temperatures, by H. J. French; Microstructure of Iron and Mild Steel at High Temperatures, by H. S. Rawdon and Howard Scott; Physical Changes in Iron and Steel Below the Thermal Critical Range, by Zay Jeffries; Graphitization of White Cast Iron, by R. S. Archer; Application of the Microscope to the Malleable-Iron Industry, by Enrique Touceda.

Alloy Steels Session, Wednesday, Feb. 18, 2 p.m. Papers to be presented: The Coefficient of Expansion of Alloy Steels, by John A. Mathews; Critical Ranges of Some Commercial Nickel Steels, by Howard Scott; Forgeability of Iron-Nickel Alloys, by T. D. Yensen.

Among other papers included in the program are the following: Rise and Decline in Production of Petroleum in Ohio and Indiana, by J. A. Bownocker; Petroleum Resources of Kansas, by Raymond C. Moore; Rôle of Bed-Rock in the Distribution of the Hydrocarbons, by M. M. Monte-Flores; Water Displacement in Oil and Gas Sands, by Roswell H. Johnson; Oil Fields of Kentucky and Tennessee, by L. C. Glenn; Petroleum in the Philippines, by W. D. Smith; A Résumé of the Pennsylvania-New York Oil Field, by R. H. Johnson and Stirling Huntley; Petroleum in the Argentine Republic, by Stanley C. Herold; A Foreign Oil Supply for the United States, by George Otis Smith; Petroleum Resources of Great Britain, by A. C. Veatch; Geologic Distillation of Petroleum, by Bailey Willis; International Aspects of the Petroleum Industry, by Van H. Manning; The Composition of Petroleum and Its Relation to Industrial Use, by C. F. Mabery; Low-Temperature Carbonization of Coal, by S. W. Parr and T. E. Layng; Examination of Ores and Metals in Polarized Light, by Fred E. Wright.

Registration will begin, as usual, at 9 a.m. at the Institute headquarters. Lunches will be served daily at the Engineering Societies' Building. The smoker, which has become an institution, will be held for the members and male guests on Monday evening—during this time the ladies will attend a theater party. Tuesday evening the banquet will take place, while Thursday

an excursion will be taken to the Bush Terminal, Brooklyn.

Institute of Metals Division members are requested to make their headquarters at the Hotel Seville, Madison Ave. and 29th St. This hotel served the Division nicely last February. It will be glad to do so again this year and the members of this Division find special advantages in being together.

The ladies who are visiting the meeting with members are especially invited to attend the luncheons, the banquet, and other functions which have been arranged by the Ladies' Committee for each day of the meeting. An Entertainment Committee from the Ladies Auxiliary, headed by Mrs. Arthur S. Dwight, has prepared a very attractive program which will insure them a pleasant stay.

Bill to Prohibit Export of Helium

Exportation of helium is prohibited without special permit in the draft of the bill which has been submitted to Congress by the Secretary of the Navy. The President is authorized by the bill "to prescribe appropriate rules and regulations to govern the exportation of helium." Exportation of that gas without such a permit is to be punishable by imprisonment for not more than 5 yr. and not less than 1 yr., or by fine of not less than \$5,000, or both. Secretary Daniels in recommending the adoption of the measure wrote to the chairman of the Interstate and Foreign Commerce Committee as follows:

"The sources of supply of helium in the United States are not numerous and the quantity obtainable is very much limited. This gas is non-inflammable and is consequently of inestimable value for balloons of all kinds and especially for those of the dirigible types that the Navy Department is endeavoring, under authorization by Congress, to develop and bring to a state of greatest efficiency.

"It is manifest therefore that the public interests imperatively require conservation of the supply of this gas, as the demand for it abroad is insistent and great enough to consume, in all probability, within a short time the available supply in this country.

"The accompanying draft of a bill would admit of the control of the supply of this gas so that the interests of the Government would be given the maximum of protection so far as affected by this matter."

Criticism of Government Expenditures at Muscle Shoals

Government nitrate plants at Muscle Shoals, at Toledo, and at Cincinnati came in for particularly severe criticism at a hearing Feb. 3 before the Graham committee of the House of Representatives. The author of the more serious charge of inefficiency in the handling of the Muscle Shoals project is Fred H. Wagner of Johns Hopkins University. Mr. Wagner formerly was a Lieutenant Colonel in the Ordnance Department and from July, 1918, to May, 1919, was Director of Operations at Muscle Shoals. Patriotism was forgotten at Muscle Shoals, Colonel Wagner asserts. Extravagance not only was permitted but was encouraged, he says. Among points brought out by Colonel Wagner was the fact that a number of former New York City officials held some of the more prominent official positions connected with the Muscle Shoals work. These officials, whom he named, formerly were connected with the New

York Fire Department, Street Cleaning Department, and other municipal activities which were in no way connected with the chemical industry.

Colonel J. W. Joyes of the Nitrate Division of the Ordnance Department was called before the committee to explain the purchase of a limestone quarry at Waco, Ala., thirty miles from the Muscle Shoals plant. It had been charged that this action on the part of the Government had put private enterprise engaged in lime industries out of business. Colonel Joyes explained that the purchase was necessary in order to have an absolutely reliable source for limestone.

Hugh L. Cooper, who was connected with the construction of the Keokuk dam, with a large plant at Niagara Falls and other important projects, testified to the effect that he had been recalled from service in France to make an examination of the Muscle Shoals project and had spent three months there. He made recommendations as to changes which were adopted. He expressed the opinion that with a free hand he could have built the Muscle Shoals plant in three years. The Government's estimate was six years. He also stated that four or five years probably will be required to complete the Muscle Shoals plant. He explained the difficulties involved in a 24-hr. use of power as necessary in the production of nitrate as compared with the 10-hr. period for which power is required for industrial purposes in the area supplied by the Keokuk power plant.

The Government is likely to lose nearly \$15,000,000 if the Toledo (Ohio) nitrate plant should be salvaged at this time, is the opinion of Henry G. Tyrrell of New York, who also appeared before the committee. Mr. Tyrrell is a member of a firm of plant appraisers. He attempted to appraise both the Toledo and Cincinnati plants for the Government. Before the work was completed he was recalled to Washington and is still awaiting orders which never came. He attributes his separation from the work to the fact that his figures differed so widely from those of the War Department. He also stated that his efforts to appraise these plants were hampered by the failure of the officials to cooperate. He expressed the opinion to the committee that both the Toledo and Cincinnati plants were in unsuitable locations, as is the picric acid plant at Little Rock. At the time these locations were chosen it was done to satisfy certain influential interests as well as to scatter the plants to avoid congestion.

Institution of Mining and Metallurgy Awards Medals

The following awards have been made by the Institution of Mining and Metallurgy (London):

Gold Medal of the Institution (premier award) to H. Livingstone Sulman, M.Inst.M.M., in recognition of his contributions to metallurgical science, with special reference to his work in the development of flotation and its application to the recovery of minerals.

"The Consolidated Gold Fields of South Africa, Ltd." Gold Medal to William Henry Goodchild, M.Inst.M.M., for his papers on "The Economic Geology of the Insizwa Range" and "The Genesis of Igneous Ore Deposits."

"The Consolidated Gold Fields of South Africa, Ltd." Premium of Forty Guineas to Dr. Edward Thomas Mellor, M.Inst.M.M., for his paper on "The Conglomerates of the Witwatersrand."

A Compendium of Chemical and Physical Constants

ONE important outcome of the war is the recognition that the United States of America must take a more active part in scientific work than ever before. America has done wonderful things in chemistry, physics and other branches of science, but in spite of this she has not been accorded recognition as a scientific nation. What is more, America serenely accepted the world's estimation and made no effort to get her just dues. This fact we accepted so absolutely that no teacher of the science thought his education complete unless he received a degree after taking a course of study in some foreign university. And many a man has gone to get a foreign education which might or might not be better than that which he could have obtained in this country, simply for the éclat which a foreign diploma gave him. Few non-scientific people realize that the best and most complete works on chemical and physical constants are written in German. To be sure, these are woefully out of date in many respects and they are perhaps known as much for the vast amounts of fundamental knowledge which is missing as for what is contained therein. Much of the knowledge contained therein is incorrect and many divergent values are given without any critical comment to enable the searcher to pick the right one. They are poorly indexed and abominably compiled. But in spite of all these drawbacks and many others which might be mentioned, they are still the most complete source of information gathered in one volume. Being written in German they are hard to understand and American industry because of this fact obtains only a fraction of the matter available therein.

GERMAN LITERATURE AN AID TO ALLIES IN THE WAR

A fact which is not generally known is that during the war the colleges, universities and the industries were combed for copies of Landolt and Börnstein's Tabellen, and that hundreds of these works were in daily use in the Army, Navy, Airplane and Medical Departments, to say nothing of those used by the Council of National Defense, National Research Council, Shipbuilding and Explosive Departments and many other departments too numerous to mention here. Many Germans figure that it was their literature that defeated them in this war.

It is proposed to issue a critical compendium of chemical and physical constants, which shall be up to date and correct; and which shall contain such new constants as can be determined before the time of publication as well as many which have been determined but which are not now generally available.

DECISION TO PUBLISH TABLES

At a meeting of the Inter-Allied Chemical Conference held in London, July 14-17, 1919, there was formed an International Union of Pure and Applied Chemistry, and it was voted that "Critical tables of physical and chemical constants shall be published in the United States and there shall be created an American publication committee charged with the general organization and the prosecution of the work."

At the meeting of the International Research Council held in Brussels on July 22, 1919, the International Union of Pure and Applied Chemistry became the Chem-

ical Section of the International Research Council. The vote in regard to the publication of critical tables of physical and chemical constants was confirmed by the Chemical Section and by the Physical Section.

BOARD OF TRUSTEES APPOINTED HERE

This work has been undertaken by the National Research Council in co-operation with the American Chemical Society and the American Physical Society. The business arrangements are to be in the hands of a board of three trustees: Mr. Hugh K. Moore, chairman, (appointed by the National Research Council); Mr. Julius Sieglitz, (appointed by the American Chemical Society); Mr. Edward P. Hyde, (appointed by the American Physical Society). By a vote of the National Research Council, these gentlemen have been authorized to raise by subscription \$100,000 and as much more as may be found necessary in order to meet the probable deficit which will result from carrying out the task assigned to the United States by the International Research Council.

AID ASKED IN THE TREMENDOUS TASK

It will be seen that America has undertaken a tremendous task. All our colleges have certain information which they can impart. There is a vast amount of knowledge in the research laboratories of the industries. It will be the duty of those in charge to collect and tabulate all this information. Not only this, but an effort will be made to obtain from the business concerns of the country a list of the physical and chemical constants which they require in their business and as far as possible have these determined and included in the work. The information contained therein will be of immense value to all industries using chemical or physical processes.

It is hoped that when manufacturers are approached for funds they will contribute liberally. It is not only good business to support this movement, but it is a patriotic duty. How can the United States hope to be a leader in scientific development, if everyone has to go to foreign publications for information?

In fact, it appears already as though even this information will no longer be all available, since it is reported that there is a movement on hand to prevent the exportation of any more German scientific literature. It is therefore becoming increasingly important that the United States should not only be self-sustaining in regard to this matter, but should take the leadership.

Civil Service Examinations

The Civil Service Commission announces the following examinations:

Associate physicist qualified in physical metallurgy, for men only, at salaries ranging from \$2,000 to \$2,800 a year. Applications will be received until further notice.

Assistant physicist qualified in physical metallurgy, for men and women, at salaries ranging from \$1,400 to \$1,800 a year. Applications will be received until further notice.

Pyrotechnic engineer. Duties will be to assist in development of design, test and manufacture of military pyrotechnics, and, in addition, will be those of an observer and firer from aircraft. Salary: Grade 1, \$2,400 a year; Grade 2, \$3,600 a year. Apply on Form 1312 before Feb. 17.

Proposed Substitute for Dye Licensing System

WHILE the last word has not been heard in the controversy over the licensing of dye imports, it seems certain that the main objections of the opponents of this plan have been met by the modifications now under consideration by the sub-committee. The sections referring to the licensing system in the original Longworth bill have been stricken out and replaced by the United States Tariff Commission's plan. The final wording is still uncertain, as Joseph H. Choate, Jr., has suggested certain changes.

CHANGES IN DUTIABLE LIST

The following articles have been removed from Group III., sec. 500, that is, the finished product group, for which a duty of 45 per cent ad valorem is provided:

Natural alizarin and natural indigo, and colors, dyes, stains, color acids, color bases, color lakes, leuco-acids, leuco-bases, indoxylic and indoxylic compounds obtained, derived or manufactured in whole or in part from natural alizarin or natural indigo; natural methyl salicylate or oil of wintergreen or oil of sweet birch; natural coumarin.

In place of these natural products the following higher sugars have been substituted:

Adonite, arabinose, dulcitol, galactose, inositol, inulin, levulose, mannitol, mannose, melezitose, raffinose, rhamnose, sorbitol, xylose, and other of the higher saccharides required for scientific purposes.

TARIFF COMMISSION PLAN

The new section 504 provides that no article on the dutiable list shall be imported into the United States unless the Tariff Commission shall determine that such article (or a satisfactory substitute) is not obtainable in the United States on reasonable terms as to quality, price and delivery, and that the article is required for use by an actual consumer in the United States. In addition, Mr. Choate proposes that the Tariff Commission prepare, after investigation, a list, to be known as the importable list, of such products as may be found by it to fulfill the above requirements for admission to import.

The phrase "reasonable terms as to price" for any article is defined as the lowest price, for the time being, which, in the judgment of the Tariff Commission, shall be sufficient to insure the maintenance in the United States of the production of such article by an efficient plant operating on a substantial commercial scale.

SUGGESTIONS AS TO PROCEDURE

All details as to practice and procedure are to be determined by the Tariff Commission. Mr. Choate suggests that such rules and regulations shall be so framed as to prevent the importation of any article in quantities sufficient to discourage manufacture of the same in the United States, or to provide any consumer with supplies from any source exceeding his needs for six months in advance, or to cause an accumulation in the United States of more than a six months' supply for the country as a whole.

EXTENSION OF WAR TRADE BOARD LICENSES

Notwithstanding the prior termination of the present war the provisions of the trading with the enemy act

¹H. R. 8,078; Sec. 503(a) to 503(d) inclusive, Sec. 504. The bill passed the House of Representatives Sept. 26, 1919, and was referred to the Senate Committee on Finance Sept. 29, 1919.

are to be continued for ninety days after the date of the taking of effect of this act and all individual licenses issued by the War Trade Board section of the State Department during this period are to remain in effect. At the end of this period all records, etc., relating to individual import licenses for articles on the dutiable list are to be turned over to the Tariff Commission.

For the purpose of enforcing this act, the Tariff Commission has the right to demand from manufacturers, dealers and importers sworn statements as to production, stocks on hand, cost of production, price, etc. Such information shall be confidential, of course, and shall not be published except in the form of tables, averages and summaries which shall not disclose the operations of individual domestic manufacturers.

American Chemical Society, Chicago Section Meeting

The January meeting of the Chicago Section of the American Chemical Society was held at the City Club, Jan. 16. The principal speaker of the evening was Dr. Clarence W. Balke, who spoke to the members on the metallurgy and manufacture of tungsten.

Dr. Balke covered at considerable length the process of manufacture employed at the Fansteel Products Co.'s works in North Chicago, a full description of the operation of which was published in the Jan. 7 issue of CHEMICAL & METALLURGICAL ENGINEERING.

New York Section, A. I. M. E., Elects Officers

At the regular February meeting of the New York Section of the American Institute of Mining and Metallurgical Engineers held on Feb. 4, the following officers were elected for the ensuing year: Chairman, E. P. Mathewson; vice-chairmen, William Y. Westervelt and D. M. Liddell; treasurer, E. L. Gruver; members of the executive committee, S. H. Ball and A. F. Keene.

The subject of the meeting was Foreign Trade. The speakers were G. A. O'Reilly, of the Irving National Bank, and V. Gonzales, of the Mercantile Bank of the Americas, and Dr. John F. Crowell, of the R. G. Dun Co.

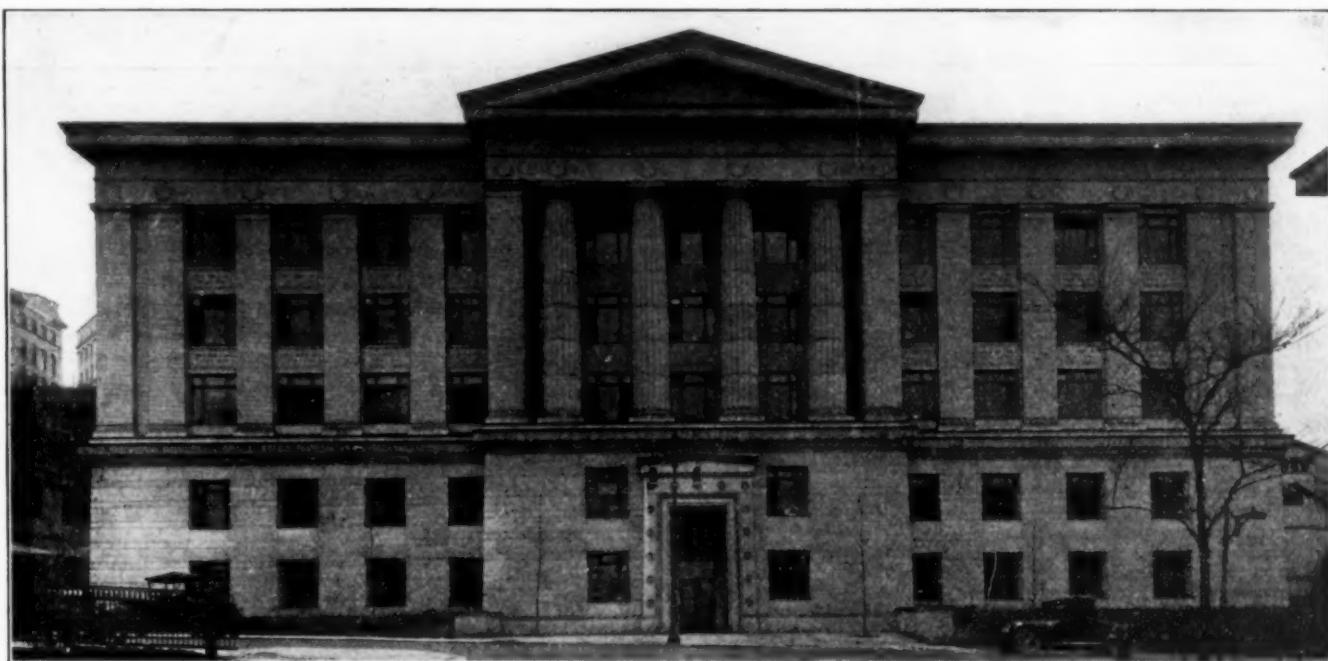
Stretched Wire Apparatus for Measuring Thermal Expansions

An unfortunate piece of printers' pi was dished up to the readers of A. W. GRAY'S article on the above subject in CHEMICAL & METALLURGICAL ENGINEERING of Nov. 26-Dec. 3, 1919, prepared during the printers' strike. The matter immediately preceding the first subtitle on page 668 should read:

"Molybdenum repeats better than most substances, and is, therefore, well suited for exhibiting the reliability of expansion apparatus."

"The precision easily attainable with stretched wire expansion apparatus is also well illustrated by the routine practice of plotting to a large scale the deviations of individual measurements from the quadratic which best represents an entire series. This method is useful not only for adjusting observations, but also for locating transition regions with precision, as can be seen by examining the deviation curves published by Merica and Schad."

On page 670 the word "or" in line 16 of the first paragraph should have been "of." In the seventh line of the last paragraph of this section the fraction " $\frac{5}{4}$ " is omitted before the words "the expansion of AJ."



MELLON INSTITUTE OF INDUSTRIAL RESEARCH

Industrial Research at the Mellon Institute

A Concise Account of the Fellowship System of Industrial Research—Developments in Bread, Laundering, Refractories, Dental Cements, Magnesia Insulation, Insecticides, Protected Metals, Paper Containers, Flotation, and Testing of Leather Belting

BY WALLACE SAVAGE

BING inquisitive to know just what the accomplishments were that had created the great repute in industrial circles of the Mellon Institute of Industrial Research in its brief eight years of activity in Pittsburgh, the writer made a survey of the pertinent literature. Reviewing backwards, the first clue was found in "Some Present-Day Problems of Chemical Industry."¹ Here was listed a selection of problems such as are taken at the Institute for investigation, together with a few preliminary general remarks on the methods of industrial research. Being in quest of solved problems, "The Industrial Fellowships of the Mellon Institute"² was scrutinized next. The progressive growth in the number of industrial fellowships and fellows, together with the increase in contributions, shown

predicted in his writings.³ However, after examining the indexes of several of the publications especially representing industries having fellowships, it soon became apparent that the reports on the findings were voluminous as well as widely scattered, and that the most convenient source for the desired information was to be had by direct interview with the directors and the industrial fellows of the Institute.

ORGANIZATION AND ADMINISTRATION

In the spring of 1913, Andrew W. and Richard B. Mellon gave a sum of money which was sufficient to erect a substantial home, purchase a large amount of equipment and supply an annual income of \$65,000. At present about \$250,000 are received from the fellowship donors, making the total available funds \$315,000 per annum. While the Institute is operated as a part of the University of Pittsburgh, it is independent financially and under its own management. The functions of the administrative organization are shown in the chart.

In establishing an industrial fellowship, an agreement is made between the donor and the director of the Institute, in which the donor agrees to furnish a stated amount of money, the expenditure of which shall be limited to his problem and for which he shall receive exclusive title to any results obtained. Assignments to all patents on inventions made during and germane to the fellowship are made by the fellow to his donor. The

TABLE I. ANNUAL RECORD

March to March	Number of Fellowships	Number of Fellows	Amounts Contributed
1911-1912	11	24	\$39,700
1912-1913	16	30	54,300
1913-1914	21	37	78,730
1914-1915	21	32	61,200
1915-1916	36	63	126,830
1916-1917	42	65	149,100
1917-1918	42	64	172,000
1918-1919	47	77	238,245

in this report, as recorded in Tables I and II, was certainly excellent evidence of the merits of the industrial fellowship system, in even a greater measure than the founder, the late Dr. Robert Kennedy Duncan, had ever

¹Bacon and Hamor, *J. Ind. Eng. Chem.*, vol. 11, p. 470.

²Bacon, *J. Ind. Eng. Chem.*, vol. 11, p. 371.

³"The Chemistry of Commerce" and "Some Chemical Problems of Today."

TABLE II. INDUSTRIAL FELLOWSHIPS IN OPERATION, 1919

Numbers and Names of Industrial Fellowships	Industrial Fellows, Names and Degrees	Foundation Sums and Dates of Expiration
117—Window Glass.....	(Fellow to be appointed).....	\$3,000 a year. Bonus: \$2,000.
127—Collar.....	H. D. Clayton (B.A., Ohio State University).....	\$2,800 a year. June 14, 1919.
129—Illuminating Glass.....	A. H. Stewart (B.A., Washington and Jefferson College).....	\$2,100 a year. October 1, 1919.
145—Soap.....	(Fellow to be appointed).....	\$2,000 a year.
150—Enameling.....	R. D. Cooke (M.S., University of Wisconsin).....	\$2,600 a year. April 1, 1919.
151—Leather Belting.....	P. G. McVetty (M.E., Cornell University), senior fellow. R. H. Edson (B.A., Clark College)	\$4,900 a year. April 1, 1919.
152—Refractories.....	R. M. Howe (M.S., University of Pittsburgh), senior fellow. B. M. Burchfiel (B.A., Southwestern College). E. N. Jessop (B.S., University of Pittsburgh). S. M. Phelps (assistant).	\$7,000 a year. May 1, 1919.
153—Canning.....	M. R. Daughters (M.A., University of Nebraska), (second fellow to be appointed).....	\$6,000 a year. May 1, 1919.
154—Paper.....	Howard Curtis (B.A., Washington and Jefferson College).....	\$2,175 a year. June 1, 1919.
155—Protected Metals.....	J. H. Young (Ph.D., Ohio State University).....	\$3,000 a year. June 1, 1919.
156—Physiological Research.....	K. K. Jones (M.S., Kansas State Agricultural College).....	\$4,000 a year. August 1, 1919.
157—Dental Products.....	C. C. Vogt (Ph.D., Ohio State University).....	\$2,000 a year. July 1, 1919. Bonus: Royalty on sales.
158—Leather soling.....	C. B. Carter (Ph.D., University of North Carolina).....	\$3,500 a year. June 1, 1919.
159—Copper.....	C. L. Perkins (B.S., New Hampshire College).....	\$5,400 a year. July 1, 1919.
160—Oil.....	R. E. Sayre (M.S., University of Wisconsin).....	\$10,000 a year. Sept. 1, 1919.
161—Glass.....	W. F. Faragher (Ph.D., University of Kansas), senior fellow. W. A. Gruse (Ph.D., University of Wisconsin).....	Bonus: \$10,000.
162—Gas.....	R. R. Shively (Ph.D., University of Pittsburgh).....	\$4,000 a year. Sept. 1, 1919.
163—Aluminum.....	J. B. Garner (Ph.D., University of Chicago), senior fellow. H. B. Heyn (B.S., University of Wisconsin).....	\$7,500 a year. Sept. 15, 1919.
164—Alloy.....	E. O. Rhodes (M.S., University of Kansas), senior fellow. R. B. Trusler (B.S., Syracuse University).....	\$6,500 a year. Sept. 15, 1919.
165—Coffee.....	O. E. Harder (Ph.D., University of Illinois).....	\$3,500 a year. Oct. 1, 1919.
166—Food Container.....	C. W. Trigg (B.S., University of Pittsburgh).....	\$2,250 a year. Oct. 1, 1919.
167—Magnesia.....	F. W. Stockton (B.A., University of Kansas).....	Bonus: 2 per cent of gross profits.
168—Yeast.....	M. S. Mason (M.S., University of Illinois).....	\$5,000 a year. Oct. 16, 1919.
169—Copper.....	R. H. Heilmann, assistant (University of Pittsburgh) Ruth Glasgow (M.S., University of Illinois), senior fellow. Grace Glasgow (M.S., University of Illinois). G. S. Brattan (B.A., University of Tennessee). F. M. Hildebrandt (Ph.D., Johns Hopkins University). W. H. Randall, assistant (George Washington University).....	\$6,000 a year. Jan. 1, 1920.
170—Household Utilities.....	G. A. Bragg (B.S., University of Kansas), senior fellow. J. W. Schwab (B.S., University of Kansas).....	\$15,000 a year. Nov. 1, 1919.
171—Asbestos.....	F. F. Rupert (Ph.D., Massachusetts Institute of Technology).....	\$5,000 a year. Nov. 1, 1919.
172—Silicate.....	E. R. Edson (B.A., Clark College).....	\$3,500 a year. Nov. 1, 1919.
173—Fiber.....	A. F. Shupp (Ph.D., University of Pittsburgh).....	\$2,500 a year. Dec. 1, 1919.
174—Glycerine.....	M. G. Babcock (M.S., Iowa State College).....	\$3,000 a year. Nov. 15, 1919.
175—Light Metals.....	J. D. Malcolmson (B.S., University of Kansas).....	\$5,000 a year. Nov. 15, 1919.
176—Fuel.....	R. K. Brodie (M.S., University of Chicago).....	\$1,000 a year. Nov. 15, 1919.
177—Toilet Articles.....	Melvin DeGroote (B.Ch.E., Ohio State University).....	\$4,000 a year. Dec. 1, 1919.
178—Silverware.....	P. V. Faragher (Ph.D., Massachusetts Institute of Technology).....	\$5,000 a year. Jan. 1, 1920.
179—Organic Solvents.....	J. G. Davidson (Ph.D., Columbia University).....	\$3,500 a year. Dec. 11, 1919.
180—Keratin.....	(Fellow to be appointed).....	\$2,500 a year. Dec. 11, 1919.
181—Synthetic Resins.....	(Senior fellow to be appointed). A. E. Coxe (B.S., University of Chicago).....	\$5,600 a year. Jan. 1, 1920.
182—Byproducts Recovery.....	Walther Riddle (Ph.D., University of Heidelberg). H. E. Gill, assistant (University of Pittsburgh).....	\$4,000 a yr. Jan. 1, 1920. Bonus: \$5,000. \$5,000 a year. Dec. 23, 1921.
183—A. Organic Synthesis.....	G. O. Curme, Jr. (Ph.D., University of Chicago), senior fellow. H. R. Curme (Ph.D., University of Pittsburgh). J. N. Compton (M.S., Columbia University). C. O. Young (Ph.D., University of Pittsburgh). E. W. Reid (M.S., University of Pittsburgh).....	\$3,000 a year. Jan. 1, 1920.
183—B. Organic Synthesis.....	H. A. Morton (Ph.D., University of Pittsburgh), senior fellow. C. J. Herrly (B.S., Pennsylvania State College).....	\$32,400 a year. Jan. 1, 1920.
184—Coke.....	F. W. Sperr, Jr. (B.A., Ohio State University), advisory fellow. O. O. Malleis (M.S., University of Kansas).....	\$7,020 a year. Jan. 1, 1920.
185—Insecticides.....	L. R. Office (B.S., Ohio State University).....	\$3,500 a year. Jan. 1, 1920.
186—Fertilizer.....	H. S. Davis (Ph.D., Harvard University).....	\$4,000 yr. Jan. 5, 1920. Bonus: \$5,000.
187—Glue.....	O. F. Hedenburg (Ph.D., University of Chicago).....	\$2,500 a year. Jan. 5, 1920.
188—Distillation.....	H. H. Meyers (B.S., University of Pennsylvania).....	\$3,000 a year. Jan. 5, 1920.
189—Laundry.....	R. H. Boggs (M.S., Massachusetts Agricultural College).....	\$5,000 a year. Jan. 18, 1920.
190—Bread.....	David Drogin (M.S., University of Pittsburgh). H. G. Elledge (M.S., University of Pittsburgh). Alice L. Wakefield, assistant (B.S., Margaret Morrison). H. A. Kohman (Ph.D., University of Kansas), senior fellow. Roy Irvin (M.S., University of Kansas).....	\$10,000 a year March 1, 1921. Bonus: \$10,000.
191—Fruit Beverages.....	R. J. Cross (B.A., Leland Stanford Jr. University). H. A. Noyes (M.S., Massachusetts Agricultural College).....	\$3,000 a year. March 1, 1920.

fellow and the directors are granted open access to the donor's factory and the co-operation of its operating staff. Reports on the findings of the research can be published with the consent of the company at any time or after three years from the completion of the fellowship work by permission of the director upon the decision that such publicity would not unduly injure the interests of the donor.

The Institute in its relation to a fellowship has two important functions. It brings into association a body of men having a wide variety of knowledge in pure and applied science and furnishes them with extraordinary facilities for augmenting and applying the same. While interconsulting among the fellows is largely done through the directing staff, free direct intercourse on scientific matters is permitted. The potency of this aggregation of specialists increases with the number of fellowships and the variety of industries represented by them. At the conclusion of a research, the donor of a fellowship often will have available the services of a

man of training superior to that obtainable in the university or technical school and immediately adaptable to his particular requirements. The Institute is producing industrial specialists of its fellows, in the increased ability of whom the community will eventually be more benefited than by the most successful conclusion of any of their researches.

INDUSTRIAL FELLOWSHIPS

Industrial fellowships are usually founded by individual companies, but there are at present nine important association fellowships. These are shown in Table III. It is the intention of the administration to encourage this class of donors, because the benefits derived from their type of investigations will normally have the widest distribution.

Where the research involves more work than can be performed by one fellow, a sufficient staff, known as a multiple fellowship, is appointed, responsible through a senior fellow to the administration.



ADMINISTRATION
H. S. Coleman W. A. Hamor E. W. Tillotson
R. F. Bacon E. R. Weidlein D. S. Pratt

A very brief description showing the accomplishments of six of the association fellowships and four of the company fellowship investigations will now be given as affording examples of the work done at the Institute.

Laboratories, outside unit plants and experimental equipment will not be described further than can be done by the accompanying selection of illustrations.

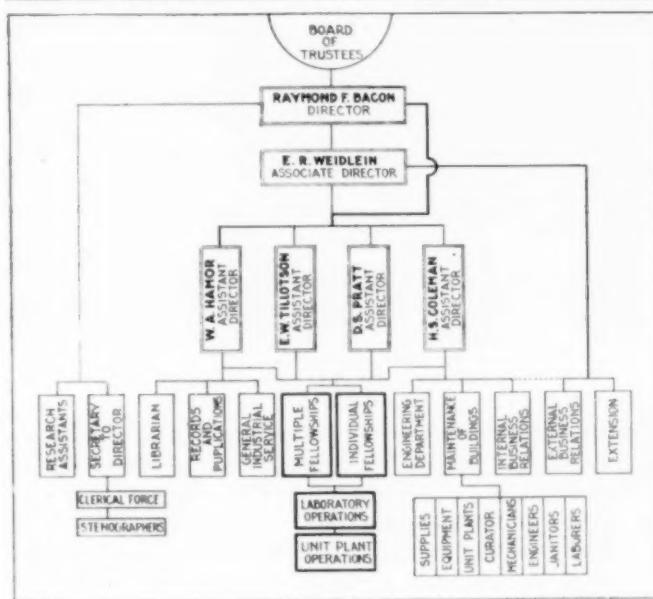
BREAD FELLOWSHIP

During the pioneer days of the industrial fellowship system at the University of Kansas, Dr. Henry A. Kohman isolated and grew a pure culture of spores concerned in the fermentation of "salt-risin" bread. This was very noteworthy, as it was the first scientific con-

⁴"Description of the New Building of the Mellon Institute," Hamor, *J. Ind. Eng. Chem.*, vol. 7, p. 333.

TABLE III. ASSOCIATION FELLOWSHIPS

	Companies	Foundation Sum
Leather belting	40	\$4900
Refractories	84	7000
Canning	71	6000
Leather soling	60	3500
Magnesia products	4	6000
Asbestos	10	3500
Fiber board containers	20	3000
Insecticides	9	3500
Laundry	2500	5000



ADMINISTRATION CHART

tribution of importance to the ferment bread-leavening industry. Since the introduction of these spores, "salt-risin" bread has been steadily increasing in commercial importance. Less than $\frac{1}{2}$ per cent of the weight of the bread stock is lost in this spore-leavening process, which, when compared to the 5 per cent loss in ordinary yeast leavening, will be readily acknowledged by any one acquainted with baking finances to be of vast economic importance. While nothing has been accomplished toward elucidating the enzyme action of the spore, its products have been found to be mainly edible

organic acids, such as lactic, and gases consisting of one-third carbon dioxide and two-thirds hydrogen. Dr. Kohman now markets these spores in quantity lots to the bakery trade.

In 1911, after reading Dr. Duncan's chapter on "Bread" in "Some Chemical Problems of Today," George S. Ward, of the Ward Baking Co., of New York, decided to establish a multiple fellowship and find out whether science could improve on the art of bread making as it had been passed on after the lifelong and collective efforts of hundreds of generations of bakers.



FELLOWS' ROOM

Dr. Kohman, already being the recognized genius in applying science to this industry, was chosen to take the fellowship.

Within a short time "Arkady" yeast food was evolved. In the old process of leavening, the yeast derived its nourishment mainly from the soluble sugar, mineral salts and protein contents of the dough. Considerable time appeared to be lost in the breaking down of the proteins by the yeast, so Dr. Kohman experimented with ammonium salts as a substitute for this complex source of nitrogen. The yeast thrived and generated the leavening carbon dioxide in a much more efficient manner. The brewing industry for generations had known that lime salts were an important tonic,

so Dr. Kohman studied their application and found that they were of great value. Hints taken from the chemical fertilizer industry did not prove so profitable, with the result that potash and soluble phosphates were found to contribute nothing. The wheat flour carried a sufficient content of these latter salts, while the others, though present, were in insufficient amounts adequately to supply the appetite of the yeast.

After Dr. Kohman had mastered the yeast-feeding problem, he found that it was possible to hasten the aging or maturing process. This was believed to be an



LIBRARY AND READING ROOM

oxidation phenomenon, wherein the leavened dough cell walls became more viscous and elastic. A small addition of potassium bromate was eventually found to give the desired oxidation necessary to the aging process. The most efficient mixture of salts so far determined has been found to be 100 g. of ammonium chloride, 240 g. of calcium sulphate and 3 g. of potassium bromate to the 200 kg. of flour used. The decrease in the amount of sugar lost in leavening fermentation is about 27.5 lb. per ton of flour. Only half as much yeast is required, so it can be said that the cost of leavening bread with yeast has been cut in two by the discovery and adoption of "Arkady" yeast food.

LAUNDRIES OWNERS' NATIONAL ASSOCIATION FELLOWSHIP

About one-half the laundry companies in the United States, representing a business of at least \$150,000,000, through their Association, are the donors of the laundry multiple fellowship. Harvey G. Elledge, assisted by Miss Alice L. Wakefield, has given individual attention to numerous problems as they have arisen in the plants of the Association throughout the country. Poor textiles and dyes nearly always do not impressively come into evidence until they have been laundered. An accompanying photomicrograph, Fig. B, illustrates what to the unaided eye would pass for silk cloth. The large cotton filling threads and the few bushed out unspun silk fibers make a combination which is almost as delicate as a spider web. A shirt made of this material failed to survive intimate contact with soap and water even when carefully laundered by hand.

A fading dye does not give as serious trouble as a mixed blend, one important member of which is not fast. The owner of what was a blue shirt can rarely be made to be contented with the delivery of the same article washed out to some other color. More serious

trouble arises when the fabric has been tendered in dyeing, for then the oxy cellulose formed passes into the soapsuds emulsion along with the soiling materials. Fig. A represents a blue bandana handkerchief, having white dots, which were made by removing the dye by printing with stripping salts. Failure to wash out these corrosive salts promptly, if at all, permitted the formation of non-fibrous oxy cellulose, and, when the handkerchief was laundered, the product looked as though it had received pretty rough treatment.

Such occurrences, becoming more and more common in these days of higher prices and lowered production, have given to the laundry fellowship the added purpose of educating the public to the necessity for discrimination in purchasing, which is the only method that can successfully eliminate the present condition of unfair prejudice against the power laundry. This purpose, in connection with the original object of investigation of the actual problems of conducting a power laundry in so far as they are related to chemistry, has opened a field which, when it has been fully developed, shall have increased the store of chemical and industrial information many-fold. One of the most useful of the recent accomplishments of the laundry fellowship has been the working out of standard washroom formulas. These scientific procedures are now in use in the laundries of the Association membership.

REFRACTORIES MANUFACTURERS' ASSOCIATION FELLOWSHIP

Two and one-half years ago, the Refractories Manufacturers' Association founded a multiple fellowship at the Institute for the main purpose of developing standard tests to be used in the specifications of refractories. Simple tests that could be interpreted to or would directly indicate the properties of a refractory in actual use were very much desired. A fuller understanding of the purpose of the tests and a discontinuance of mis-



TYPICAL SMALL LABORATORY

application of them in many specifications of consumers were also sought. Incidentally, it was believed that improvements in refractory products would be a sequel to better methods of testing.

Raymond M. Howe and a staff of three are amply meeting the expectation of the donors of the fellowship. They have aided much in clearing up the variation of



AISLE OF LABORATORY SUPPLY ROOM

fusion with respect to time of heating and under loads. Slag penetration and abrasion, spalling and changes in volume under reheating are all being kept under consideration. At present the clay silicates form too complicated a system for their properties to be resolved to and conceived by a few fundamental physical laws. Whatever advance is made in this direction will first be associated with simpler materials such as magnesia and silica products. In the case of magnesia, extensive investigations have been required to develop a domestic product having the properties of that formerly imported. The effect of the basic fluxes such as lime, iron oxide, etc., on the slaking, slagging and general stability in use was sufficiently determined to give the data required for the production of satisfactory magnesia products from domestic magnesite.

The most outstanding among the industrial contributions of this fellowship is an improvement in manufacturing auger machine-made brick. While such firebrick find wide commercial application because of their uniformity and density, they are sometimes regarded with skepticism because of a more or less laminated structure. These laminations are the result of the center of the clay column moving faster than the exterior, due to the resistance caused by the surface of the die. It has been found that this lamination may be removed by repressing the soft unburned bricks on edge, thus overcoming the prejudice of the mason who has trouble in accurately breaking a laminated brick, retaining the economy of the process, and extending the application of such bricks to larger fields.

THE DENTAL PRODUCTS FELLOWSHIP

The Lee S. Smith & Son Manufacturing Co. was not satisfied with the opaque dental cements in general use up to 1915 and desired to manufacture a translucent tooth-like product, highly resistant to physical and chemical action. Dr. C. C. Vogt was chosen to work on that problem at the Institute. The non-translucent

cements used prior to the completion of Dr. Vogt's work consisted of an opaque aggregate of metal oxides, such as zinc, etc., bonded together by insoluble translucent phosphate salts, formed by the reaction between the basic aggregate and phosphoric acid. Dr. Vogt's problem ultimately simmered down to producing a basic translucent aggregate. By fusing his metal oxide with fluxes such as feldspar, silica and fluorides, he was eventually able to get just such a translucent basic aggregate as he desired. Considerable investigating was required to select the best formulæ and to meet all the specifications. The nation-wide adoption of the cement by the dental profession within the last three years is ample testimony of the success of this fellowship.

MAGNESIA ASSOCIATION FELLOWSHIP

Reliable heat data on insulation materials, especially 85 per cent magnesia, are required to enable manufacturers to know what a given investment in insulation materials will net them on their fuel account. In 1918 Glen D. Bagley and R. H. Heilman held the fellowship, and during the present year M. S. Mason and Mr. Heilman have proceeded with the investigation.

The method of procedure is to measure the electrical energy input required to maintain a given temperature difference between the test pipe and the air in the room. The pipe is heated by means of three separate electric heating coils which are arranged end to end within the pipe. When the thermocouples in the pipe wall indicate that the center and the end sections are at the same

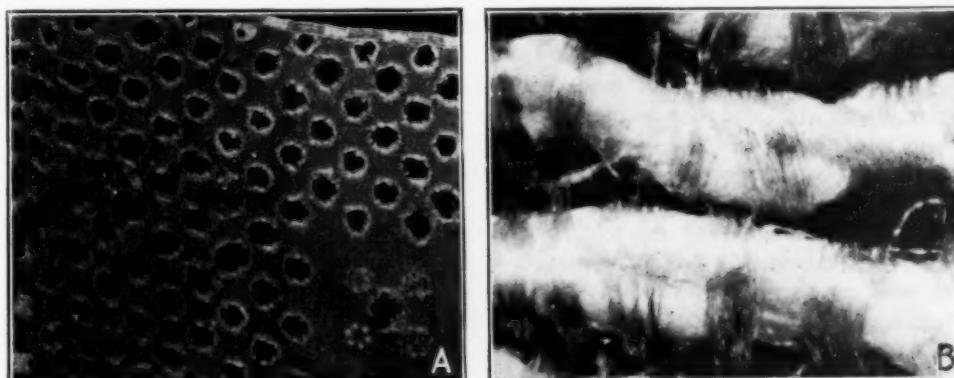


FIG. A. COTTON TENDERED WITH STRIPPING SALTS. FIG. B. UNIQUE COTTON-SILK WEAVE

temperature, there is no longitudinal flow of heat within the pipe. Under such conditions the energy supplied to the center section of the pipe must flow radially through the covering of the center section and be lost by radiation and convection. From the heat equivalent of the electrical energy supplied to the center section, the loss per unit area of pipe surface can be calculated. The investigation will be continued to find how these losses are affected by variations in covering and ranges in temperature upon exposure under all possible factory conditions. Excellent sets of curves showing heat losses, steam costs and economical sizes of magnesia insulation have been put out by the association under whose auspices the research work is being carried out.

THE REX INSECTICIDE FELLOWSHIP

A number of arsenates and arsenites have been manufactured by various companies for insecticidal purposes, but the arsenates of lead and of calcium have proved to be the best. The former may be used on all

kinds of foliage, but the latter should not be used on stone fruits, although it may be used on other foliage, and especially in combination with lime-sulphur solution.

The Rex Spray Companies, desiring to improve their products and to manufacture other insecticides, became the donors of this fellowship. Dr. Oscar F. Hedenburg, industrial fellow, has made considerable progress with their problems during the past two years.

Arsenate of lead has been in use for a number of years. All brands are guaranteed to contain 30 or 31 per cent of arsenic oxide, As_2O_3 , and may contain up to 32 per cent. Arsenate of lead must not contain more than 1 per cent of soluble arsenic, calculated as As_2O_3 .

Since nearly all arsenate of lead is used in suspension in water, that product which remained in suspension the longest time, or which settled the most slowly, has been regarded the most satisfactory. Besides this property, adhesion to the foliage and spreading or covering power have been considered of great value.

As a result of work in connection with this fellowship, an arsenate of lead has been produced which exhibits to an unusual degree the properties mentioned above. It has been named "NuRexform" dry arsenate of lead. From suspension in water it separates only after standing several hours. It is so finely divided that the agitated suspension has a "silky" appearance. When sprayed onto a surface, it covers it uniformly, and, after the water has evaporated, the dry deposit cannot be washed off by a heavy flow of water. Even when a sulphide solution, such as lime-sulphur solution, is added to the suspension, this arsenate of lead darkens very little and the stability of the suspension is hardly affected. Other arsenates of lead, when treated thus, become flocculated and almost black, and as a result the property of suspension is lost. As applications for patents have only recently been filed, a more detailed account cannot be given at present.

The destructiveness of the cotton boll weevil made extensive research of effective control necessary. This work was carried on by the Government at the Delta Laboratory, Tallulah, La. Dusting cotton plants with calcium arsenate five times during the season was found to give the most effective control. An important demand for calcium arsenate was created without giving the various producers much advance notice.



UNIT PLANT—TUBE MILL INSTALLATION

Dr. B. R. Coad, in charge of the work, set the following requirements for calcium arsenate to be used in boll weevil control:

Not less than 40 per cent As_2O_3 .
Not more than $\frac{1}{2}$ per cent soluble As_2O_3 .
Density, 17 to 22 lb. per cu.ft.
80 to 100 cu.in. per lb.

The legal limit for soluble arsenic oxide is 1 per cent. The soluble arsenic value measures the tendency of an arsenate to destroy the plant tissue.

Research on this fellowship has made it possible to produce a fine, white calcium arsenate containing less than $\frac{1}{2}$ per cent of soluble arsenic, and some batches have shown only a trace of soluble arsenic.

Production of calcium arsenate containing soluble arsenic below the legal limit has been the greatest difficulty experienced by manufacturers. The manufacture of calcium arsenate with soluble arsenic far below the legal limit is a distinctive advance.

THE PROTECTED METALS FELLOWSHIP

A prominent manufacturer of a sheet steel building material which is coated with rust-proofing layers of asphalt and asbestos felt experienced great difficulty in preventing the coated sheets from sticking together, especially when they were subjected to any considerable pressure. On this account, the material could not be piled either during storage or shipment, without taking considerable risks.

Dr. J. H. Young found the solution of the problem within thirty days after the inception of the work. He obtained from cellulose an economical surfacing material, which adhered well to the asphalt coating as well as giving the desired break in contact between the asphalt surfaces.

THE CONTAINER CLUB FELLOWSHIP

The recent advent of the Webb paper and box tester was due to the unreliability of the Mullen test on corrugated fiber board. The manufacturers experienced great difficulty with the railway testing laboratories on this account. J. D. Malcolmson has spent the last year in perfecting the Webb instrument with its various attachments. A small perforated foot fitting the corrugation is so arranged that perfect support is given to the fiber, the true breaking strength of which is then measured by the perforating force of the plunger. Each wall is measured separately and the strength of the



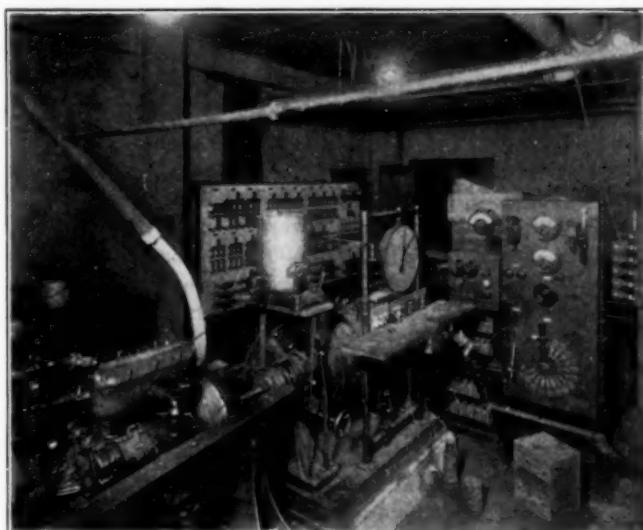
UNIT PLANTS

board is arbitrarily taken as the sum of the walls. Many of the instruments are now in operation and specifications are being drawn calling for its use. The tester is so calibrated that it gives Mullen figures on paper. A tensile strength attachment is provided so that the test figures of the Schopper instrument can also be obtained with it. A small pocket tester has also been perfected, which is intended for the use of inspectors in catching shipments that are suspected of being under specifications.

The adhesives and other raw materials used in the manufacture of boxes from the corrugated board have been considerably improved. The viscosity of water-glass has been found to rise enormously with the addition of sodium chloride. This is important in reducing the alkalinity and amount applied to obtain adhesion. Recommendations have been made to have the heavy fibers of the boards belted crosswise so as to give a maximum lateral strength. Up to the present ordinary tape has been used in strapping the boxes. This has the stronger cords running lengthwise and is designed to give high tensile strength. Resistance to lateral tears is required of box tape, so a special weave has been worked out that should prove more satisfactory than the tape now in use.

COPPER FLOTATION FELLOWSHIP

The Institute has been studying the subject of flotation for about six years. In the beginning a great deal of attention was devoted to the theory of the froth process which was then in a very confused state. As



MOTOR FUEL POWER TESTING EQUIPMENT

one result of this investigation into the mechanism of the process, the great effectiveness of alphanaphthylamine and a few closely related compounds as flotation agents for the sulphide copper in the low grade disseminated ores of the Southwest was discovered by the late Dr. H. P. Corliss. In the opinion of J. M. Callow, perhaps the foremost authority on flotation in this country, this discovery marked the greatest single improvement in the art since its introduction into the United States.

The discovery of alphanaphthylamine also opened up a whole new field for research. Recently the work of the fellowship, carried on by C. L. Perkins and R. E. Sayre, has been largely confined to the study of this field, with results which will one day constitute a very interesting

chapter in the story of the development of the flotation process.

THE LEATHER BELTING FELLOWSHIP

The Leather Belting fellowship was founded for the purpose of investigating the comparative power-carrying capacities of leather and substitute belts and to obtain definite scientific data in reference to the transmission of power by belts. For this work a complete belt testing outfit, consisting of two 100-hp. Sprague electric dynamometers, was installed at the Institute. One of these machines is arranged to operate as a motor and the other as a generator. These machines operate on 220 volts d.c. and are so connected that the output of the generator is pumped back into the line, thus making it necessary to draw on the outside source of power only to the extent of making good the losses in the machines. The fields of both machines are mounted on ball bearings to permit them to turn freely about the armature axis. The torque of the fields is indicated on dial balances through a system of levers. The dials and lever systems are so arranged that the dial reading multiplied by the r.p.m. divided by 1000 equals the horsepower. Connected to each armature shaft is a revolution counter and by the manipulation of a single switch both are either started or stopped through the medium of a magnetic clutch. By this arrangement it is possible to measure the slip of a belt to an accuracy of $\frac{1}{10}$ of 1 per cent. Since April, P. G. McVetty has been testing out all types of belting material.

PRINCIPLES APPLIED IN THE ADMINISTRATION OF ALL FELLOWSHIPS

The principles applied in the administration of the investigational activities of the Mellon Institute of Industrial Research are much the same as those followed in any other effective business. It is general experience of mankind that if it is wished to get any work well done, the way to go about it is to select competent men, extend them the largest liberties compatible with order and hold them responsible for the attainment of the desired results.

To illustrate: The industrial fellowships of the Mellon Institute are placed in charge of research chemists and engineers selected solely by reason of their special fitness for the conduct of the investigatory work concerned, and these men are accorded the privilege of being the autocrats of their own destinies within the limits of the foundation sums of their industrial fellowships. In addition, every industrial fellow receives the constant advice and collaborative support of an administrative staff which is constituted of experts in scientific research. As stated by the Carnegie Institution of Washington, whose departments of research are similarly operated, the principle applied to the incumbents of all industrial fellowships is "autonomous freedom and reciprocal accountability."

No attempt has been made to offer the reader data on which to base a comparative opinion on research as commonly performed in company laboratories and under the fellowship system as cited above. The former does not lend itself readily to brief treatment because of its extreme variation in ways, means and results. However, from such information as has been made generally known concerning isolated plant and laboratory research work, it may be stated with confidence that the fellowship system is more certain, economical and speedy in attaining results.

Classifying Organic Compounds by the Prager-Jacobson System

BY DONALD W. MACARDLE

OF THE various methods which have been proposed for the classification of organic compounds, only one, that of Richter, assigns to each compound a place determined solely by its formula. In the Richter system, the ultimate elementary composition of the substance is the criterion; this lays the system open to the grave objection that similar compounds, as ethane and propane, are in different sections, while such dissimilar compounds as allyl alcohol, propionic aldehyde, and acetone are grouped together because their empirical formulas are the same, C_3H_6O . To provide a system which shall avoid this defect, but which shall be sufficiently comprehensive to include all known organic compounds, Prager and Jacobson, the chief editors of the fourth edition of Beilstein's Handbook, have developed a method differing in many points from any heretofore proposed. The fundamental rules of this system form the introduction to the first volume of the Handbook, on which the present article is based.

MAIN DIVISIONS

If we assume that in a compound all atoms or radicals, other than hydrogen atoms, directly attached to carbon, except such as form cyclic complexes, are replaced by an equivalent number of hydrogen atoms, we obtain the "stem nucleus" of the compound. Thus the stem nucleus of (1) aminochloracetic acid ($NH_2CHClCOOH$) is ethane (CH_3CH_3); (2) of picric acid [$C_6H_2(NO_2)_3OH$] is benzene (C_6H_6); (3) of furfuraldehyde (C_5H_8OCHO) is methyl furane ($C_5H_8OCH_3$); (4) of methyl ethyl ether ($CH_3CH_2OCH_3$) is $C_2H_6 + CH_3$, etc. The stem nuclei are the first consideration in the systematic arrangement of compounds, and are divided into three groups; (I) Acyclic stem nuclei, in which the carbon atoms are united entirely in chain arrangement (examples 1 and 4 above); (II) isocyclic stem nuclei, in which carbon atoms are united in ring formation, and which have only carbon atoms for ring components (example 2); (III) heterocyclic stem nuclei, in which carbon atoms are united in ring formation not only to other carbon atoms, but also to polyvalent atoms of other elements; in this group would fall not only compounds like example 3, but such cyclic compounds as succinic anhydride, phthalimid, lactones, etc.

To these three main divisions of the system, acyclic, isocyclic and heterocyclic, a fourth division is added to include naturally-occurring organic products of incompletely known structure, such as rubber, starch, chlorophyll, etc., or complex mixtures like petroleum.

PRINCIPLE OF LATEST POSITION IN THE SYSTEM

If a compound has stem nuclei belonging to two or more main divisions, as, for example, phenyl ethyl ether ($C_6H_5O.C_2H_5$), whose stem nuclei are C_6H_5 and C_2H_5 , the compound falls in the same main division as the one of its component stem nuclei which in the system comes last. Accordingly, phenyl ethyl ether would be treated not with ethyl compounds in the first main division, but with phenyl compounds in the second. This "principle of latest position in the system" applies throughout for all such cases which arise not only in

assignment to main divisions, but in further classification into classes, sub-classes, rubrics, etc.

In the case of heterocyclic compounds a complication arises not met with among acyclic or isocyclic compounds, due to the presence in the stem nuclei of atoms other than carbon and hydrogen. This makes necessary an arrangement of these compounds into "hetero-classes," according to the kind and number of the heteroatoms (that is, the atoms in the ring other than carbon atoms). Compounds containing one or more oxygen atoms are treated first, then those with nitrogen heteroatoms, and finally heterocompounds containing both oxygen and nitrogen. In all cases arising throughout the system, derivatives of sulphur and selenium are grouped, whenever possible, with the corresponding oxygen derivatives; thus mercaptans follow alcohols directly, and thiophenes follow furanes. Sulphonic and selenic acids have, of course, no corresponding oxygen derivatives; their place in the system will be shown presently.

FORMATION OF CLASSES WITHIN THE MAIN DIVISIONS

Alteration of the stem nuclei may take place by the replacement of one or more of the hydrogens attached to the carbon atoms by "inorganic" atoms or radicals (by "inorganic" is meant elements other than carbon and hydrogen). The most important of these inorganic elements are fluorine, chlorine, bromine, iodine, oxygen, sulphur and nitrogen. The halogens appear almost always as single atoms replacing a single hydrogen, but atoms of the three latter elements, by combination with each other and with hydrogen, give rise to a very considerable number of substituent radicals, such as OH , SH , SO_3H , NH_2 , NO , NO_2 , $NH.NH_2$, N_3 , etc. It will be noticed that certain of these radicals contain one or more hydrogen atoms; these hydrogens may in turn be replaced by other atoms or groups, and thereby the number of derivatives greatly increased. These radicals containing hydrogen atoms are known as *functioning substituents*. Seven of the substituents, however— F , Cl , Br , I , NO , NO_2 , N_3 —do not contain hydrogen and so cannot undergo further substitution. For this reason they are called *non-functioning substituents*. Compounds containing non-functioning groups are considered substitution products of the compounds in which the non-functioning groups are replaced by hydrogen (or hydroxyl—see below); $NO_2CH_2CH_3$ is derived directly from CH_3CH_2 ; $ClCH_2CH_2OH$ from CH_3CH_2OH , etc., and these substitution products are included in the same class as the parent substance.

RÔLE OF FUNCTIONING SUBSTITUENTS

The functioning substituents, on the other hand, furnish the basis for the establishment of classes within the main divisions. The group $-OH$, for example, characterizes the class of hydroxy-compounds (alcohols and phenols); the group $-NH_2$, the class of amines. These classes are in turn divided into sub-classes according to whether the characteristic group appears in the molecule once or several times, whether as the sole functioning group or in conjunction with other dissimilar groups.

In the division of hydroxy-compounds it will be noted that when several hydroxy-groups are present, there are two distinct possibilities of arrangement. The hydroxyl groups may be attached to different carbons,

as in ethylene glycol ($\text{CH}_2\text{OH} \cdot \text{CH}_2\text{OH}$) and pyrogallol [$\text{C}_6\text{H}_3(\text{OH})_3$], or they may be attached to the same carbon, as in the compounds $\text{RCH}(\text{OH})_2$, $\text{RR}'\text{C}(\text{OH})_2$, $\text{RC}(\text{OH})_3$. Compounds of this type are highly unstable, but by the splitting off of water they yield the aldehydes, ketones, and carboxylic acids, RCHO , $\text{RR}'\text{CO}$, RCOOH , compounds of great importance. It would be obviously unsuitable to consider these groups of compounds as polybasic alcohols; instead the groups $=\text{CO}$ and $-\text{COOH}$ are included in the list of functioning substituents which determine classes, forming respectively the carbonyl derivatives and the carboxylic acids.

Compounds which have a functioning group and one or two other functioning or non-functioning groups attached to the same carbon atom are considered derivatives of the carbonyl-compound or carboxylic acid which results from the replacement of these substituents by hydroxyl, with subsequent splitting off of water. Thus $\text{CH}_2\text{CH}(\text{NH}_2)\text{Cl}$ is a derivative of CH_2CHO , and $\text{CH}_2\text{C}(\text{NH}_2)_2\text{Cl}$ of CH_2COOH . The same rule is followed in the case of nitrogen bound by two or three valences to carbon: e.g., $\text{CH}_2\text{CH}:\text{NH}$ is a derivative of CH_2CHO ; $\text{CH}_2\text{C}:\text{N}$ is a derivative of CH_2COOH . However, when two or three non-functioning groups are attached to the same carbon without at the same time a functioning group being attached, this rule does not apply. For example, CH_3Cl is a derivative of methane rather than of formaldehyde; $\text{CH}_3\text{CBr}_2(\text{NO}_2)$ is a derivative of ethane rather than of acetic acid.

Following these rules, and in particular the "principle of latest position in the system" mentioned above, the main divisions are divided into classes according to the functioning group present. In the complete system there are twenty-eight classes, as follows: (1) Stem nuclei; (2) hydroxy derivatives; (3) carbonyl derivatives; (4) carboxylic acids; (5-7) acids of sulphur and selenium; (8-22) nitrogen derivatives, such as amines, hydroxylamines, azo compounds, etc.; (23-28) compounds with direct bonding of carbon to polyvalent inorganic elements, as phosphine, cacodyl, etc.

DIVISION OF THE CLASSES INTO SUB-CLASSES

In the first and second main divisions and in each heteroclass, the first class is that of stem nuclei (in the acyclic and isocyclic divisions these are the hydrocarbons). These stem nuclei are divided into subclasses (homologous series) arranged according to decreasing saturation; the homologous series are in turn divided into rubrics arranged in order of increasing number of carbon atoms. The series $\text{C}_n\text{H}_{2n+2}$ would have the rubrics CH_4 , C_2H_6 , C_3H_8 , etc.; under the rubrics the individual isomers are taken up. The arrangement of the isomers is based on a few simple rules, for the discussion of which space is not available here.

With the second class begins the series of classes characterized by functioning groups; the sub-classes are here determined by the number of functioning groups present. Thus the sub-classes of this group would be monohydroxy derivatives, dihydroxy derivatives, trihydroxy derivatives, etc. Each sub-class is in turn divided into homologous series, and these into rubrics, as in the case of the stem nuclei.

In the third class a further complication is introduced: The combination of the characteristic functioning group of the class with the functioning groups of previous classes; in addition to simple carbonyl

compounds we must consider in the third group compounds containing both $=\text{CO}$ and $-\text{OH}$. Such compounds with mixed functions are always included after all the compounds containing only the single type of functioning group (with, of course, their non-functioning derivatives). In the fourth class the sub-classes would be monocarboxylic acids, dicarboxylic acids, etc., hydroxycarboxylic acids (these and the following sub-classes are arranged in the order of increasing number of oxygen atoms), carbonyl-carboxylic acids, and hydroxy-carbonyl-carboxylic acids; the sub-classes are divided as before.

INDEX COMPOUNDS AND THEIR DERIVATIVES

In the division of the classes into sub-classes, homologous series, etc., we come finally to the individual compounds which are the true representatives of the class. These are known as "index compounds," and are followed directly by such of their derivatives as are not, according to the rules previously stated, considered as index compounds to be treated elsewhere. The derivatives are of three types: (1) Functional derivatives, resulting from the alteration of the functioning group; (2) substitution products of the stem nucleus or functioning group by non-functioning substituents; (3) derivatives resulting from the replacement of functioning oxygen by sulphur or selenium.

The arrangement of derivatives of the second type (substitution products) is according to the following order of substituents: F, Cl, Br, I, NO, NO_2 , N_3 . For each index compound derivatives containing fluorine alone come first, then that with one chlorine atom (with fluorine derivatives), with two chlorine atoms (with fluorine derivatives), etc. This procedure may be briefly expressed in the rule: "First combination of the new substituent with all that precedes it, then multiplication of the new substituent, with combinations as before."

Derivatives of the first type (functional derivatives) are considered as being formed by "anhydrosynthesis"; that is, by coupling of the functioning group (if carbonyl or carboxyl, in the hydrated form) with organic compounds containing hydroxyl attached to carbon, or with inorganic hydrogen-containing compounds, the coupling taking place with the splitting out of water. The component reacting with the index compound is known as the coupling compound. Such an alteration of the functioning group of the index compound is known as an *alteration of the first degree*. If the coupling compound is capable of undergoing similar substitution, alterations of the second, third, and higher degrees are possible. In the arrangement of derivatives of an index compound, if the first degree is considered higher than the second, the second higher than the third, etc., the rule may be stated that a new derivative of a higher degree is taken up only after all the lower degree derivatives of the preceding compound of the same degree have been included.

If a functioning group can undergo simultaneously more than one first degree alteration, as in the amino group, with two replaceable hydrogens, or the hydrated carboxyl group $[-\text{C}(\text{OH})_2]$, the same rule for arrangement in the system is followed as in the case of substitution products: First combine, then multiply.

In the case of a compound with two functioning groups, if the groups are the same, a first degree alteration is made in one group (the order of the sub-

stituents being the same as the order in the series of compounds with hydroxyl attached to carbon), all derivatives of this given; then the same substitution made in the other group, all alterations of the first group given, etc. If the groups are different, the one standing earlier in the list of functioning groups is caused to undergo all possible substitutions, the other group remaining unchanged; then a first degree alteration of the second group is made, and the complete series of substitutions of this compound given, and so on.

For a full explanation of how a given complex compound is located in this system, reference must be made to the complete exposition of the system in the Handbook. Suffice here to say that the method used is the reverse of the anhydrosynthesis; the compound is considered as being resolved into its component index compounds (or their substitution products) by hydrolytic splitting, and by the constantly-used "principle of latest position in the system" the compound is located under one of its hydrolysis products.

Space is also lacking here for a summary of the rules for the arrangement in the system of compounds of easily altered structure (tautomeric substances, pseudo-acids and pseudo-bases, etc.), of diphenylmethane and triphenylmethane dyestuffs, and of a few other less important types.

In a work like Beilstein, which in the fourth edition includes more than 150,000 compounds, the system of arrangement must of necessity be complex and subject to a considerable number of more or less arbitrary rules; for a person who makes frequent reference to the Handbook no summary of the system of arrangement can take the place of a careful study of the introduction to vol. 1 (pp. 1-46), in which the system is explained in detail, with numerous examples to clear up obscure points; if the present article assists in the understanding of the introduction, or serves as a passable substitute to occasional users of the Handbook, its purpose will have been accomplished.

Semet-Solvay Co.,
Syracuse, N. Y.

Diagrammatic Outline of Arrangement of Organic Compounds

in
Beilstein's "Handbuch der Organischen Chemie"
(Fourth Edition)

Acyclic Compounds

Hydro-Carbons	Hydroxy Comp'ds	Carbonyl Compounds	Carboxylic Acids	Sulphur Acids	Amines	Nitrogen Comp'ds	Metallic Comp'ds
2-15	16-70	71-151	152-322	323-331	332-379	380-400	401-449
Cyclohexane, Cyclopentadiene, Benzene, Naphthalene	Methyl Phenol, Benzyl Alcohol, Naphthol, Resorcinol	Compounds: Benzaldehyde, Acetylbenzene, Quinone	Benzoic Acid, Chloroacetic Acid, Cyanophenoxy Acid, Phthalic Acid	Succinic Acid, Mandelic Acid, Gallic Acid	Resorcinol, Formic Acid Phthalimidobutyric Acid	Hydroxylamine, Aniline, Amino Acetone	Hydroxylamine, Aniline, Bis-anilines, etc.

Isocyclic Compounds

450-498	499-608	609-890	891-1504	1505-1591	1592-1928	1929-2251	2252-2358
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Heterocyclic Compounds

Heterocompounds with	one oxygen atom	2360-2665	Heterocompounds with	three nitrogen atoms	3794-4008
" "	two atoms	2666-2950	" "	" four or more "	4009-4187
" "	three atoms	2951-3006	" "	" oxygen and one "	4188-4483
" "	four or more atoms	3007-3031	" "	" two "	4484-4669
" "	one nitrogen atom	3032-3457	" "	" three or more "	4670-4719
" "	two atoms	3458-3793			

Organic Compounds of Uncertain Structure Found in Nature 4720-4877

The division of the Isocyclic Compounds into Classes and Sub-Classes is the same as of the Acyclic Compounds. The numbers under each Class indicate the sections included therein. The whole work is divided into 4877 sections and will appear in fifteen volumes. The first volume includes sections 1-151.

Woody Structures of Fractures of Tranverse Test-Pieces Taken From Certain Special Steels*

Observations Seem to Indicate That Acid Open-Hearth Metal Is Less Liable to Give Woody Fractures, While Molybdenum and High-Carbon Nickel Steel Give Poor Transverse Tests by Virtue of Their Chemical Composition

BY J. J. COHADE†

IT IS sometimes found in transverse tensile tests that the elastic limit and the breaking strain are practically the same or only slightly lower than in the longitudinal direction of the piece. On the other hand, contraction and elongation are lower. Impact test bars withstand a smaller number of blows; notched bars withstand, section for section, fewer kilogrammeters, and the bent layers break at a lower angle. At the same time, the fracture-surfaces are streaked with parallel lines resulting from the intersection of that surface with surfaces parallel with the axis given to the structure of the metal during forging. For this reason such fractures are described as "woody fractures."

ORIGIN OF THESE STREAKS

These streaks may result:

1. Mostly from the presence of non-metallic inclusions.
2. Much less frequently from numerous tiny blowholes.
3. From the chemical composition of the metal.
4. From overworking.

We will leave aside the influence of working, which has been very minutely and very completely dealt with by Mr. Charpy.* If exception be made of the second cause enumerated above, the three other causes intervene simultaneously in all steels and make it difficult to separate the particular influence of each on the results.

PRESENCE OF NON-METALLIC INCLUSIONS

The author will not dwell on the formation of non-metallic inclusions in steels, which has been explained by many metallurgists, and, more especially and with much care, by Dr. McCance.[†] The influence of such inclusions on defective transverse results, and therefore on woody fractures, cannot be doubted. There is sometimes found, during the manufacture of gun steel carried out with every precaution and yielding very excellent results, an occasional cast of normal composition giving poor results and woody fractures. If these be examined under a magnifying glass there will generally be seen more or less greenish inclusion stains, elongated in the direction of the streaks. In cases where a simple examination with a lens does not suffice, a microscopic examination of a small sample of the metal, after polishing and slightly etching, will reveal abnormal amounts of non-metallic inclusions. There

will be seen on the surfaces of tensile test-pieces which have given these defective results, slight cracks or, at least, faint depressions. If the bar be broken carefully, by bending, at these points, inclusions will be found.

The formation of streaks in fractures, owing to the influence of inclusions, is easily explained. The original globules, more or less ovoid in form, become flattened and elongated parallel with the direction of the flow of the metal during forging. When the steel is subjected to a tensile stress perpendicular to this direction, it cannot elongate at the points at which these inclusions are found, for at these points fracture has already taken place. What occurs is as though the bar had a series of internal parallel notches preventing the elongation of the neighboring metal and fracture takes place suddenly, passing from one notch to the next and producing the typical stepped fracture which is described as "woody" and which characterizes these steels.

PRESENCE OF NUMEROUS TINY BLOWHOLES

Tiny blowholes which have not been welded up during forging will similarly form planes of separation parallel with the direction of the working of the metal and play exactly the same part as inclusions.

CHEMICAL COMPOSITIONS OF THE METAL— MOLYBDENUM STEELS

The author was much struck in 1894 with the influence which the chemical composition of the metal might exercise on the defective results of transverse tests with woody fractures.

A series of molybdenum steels were studied in the form of small ingots cast from crucibles. The results having been very satisfactory, it was decided to run some charges in a 10-ton basic open-hearth furnace in order to ascertain what difficulties their furnace manufacture might present and to cast ingots of sufficient size to investigate their different possible applications.

One of these casts (No. 930) had the following composition:

	Per Cent		Per Cent
Carbon.....	0.360	Phosphorus.....	0.016
Silicon.....	0.041	Manganese.....	0.420
Sulphur.....	0.017	Molybdenum.....	0.470

The metal was therefore very pure and was prepared with great care.

One of the ingots was made into a gun tube. All the tensile test-pieces cut transversely gave low contractions and elongations, and woody fractures. The first impulse was to attribute this lack of success solely to the presence of oxides, or other non-metallic inclusions, inevitable when working by basic open-hearth.

It was possible, however, that the molybdenum itself

*A paper presented before the 1919 autumn meeting of the Iron and Steel Institute (British).

†Le Creusot Works.

¹See CHEM. & MET. ENG., vol. 20, pp. 216, 271 and 342.

²"Influence of Hot Deformation on the Qualities of Steel," Engineering (London), Sept. 20, 1918, vol. 106, p. 310.

³J. Iron and Steel Inst., 1918, No. 1, p. 239. See also H. Styrl, CHEM. & MET. ENG., vol. 20, p. 342.

might intervene, and to clear up this question the laboratory experiments were resumed. Two small ingots of 10 kg. each were made in the crucible, one with molybdenum and the other without. Their composition was as follows:

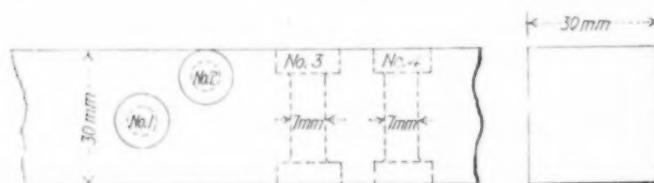
	With Molybdenum per Cent	Without Molybdenum per Cent
Carbon.....	0.300	0.450
Silicon.....	0.170	0.190
Sulphur.....	0.016	0.020
Phosphorus.....	0.029	0.026
Manganese.....	0.120	0.420
Molybdenum.....	0.530	nil

These small ingots, which were square in section (80 x 80 mm.) were transformed, by forging, into square bars 30 x 30 mm., and annealed at 900 deg. and cooled in air.

After cropping 4 per cent from the bottoms a piece 260 mm. long was cut longitudinally from each and two test-bars 13.8 mm. in diameter and 100 mm. long between punch marks were machined from them. They gave the following results:

	Elastic Limit per Sq.mm. Kg.	Tensile Strength per Sq.mm. Kg.	Elongation per Cent
With molybdenum.....	57.3	71.6	16.3
Without molybdenum.....	37.2	65.5	19.0

A length of 150 mm. was cut from the continuation of the bars which furnished the above test-pieces, quenched in water from 900 deg. C., and annealed at



LOCATION OF TEST-BARS

600 deg. C. Small transverse bars were also taken, as shown in the sketch (Fig. 1). Nos. 1 and 3 were at right angles to each other and followed the axis of the bar; Nos. 2 and 4 were similarly at right angles to each other and cut in such a manner that their heads were tangential to the side surfaces. The results of the tensile tests are given in Table I.

TABLE I. TESTS ON MOYLBDENUM STEEL

Description of the Bars	Tensile Strength Kilograms per Sq. mm.	Appearance of the Fractures.
Molybdenum steel	No. 1 96.6	Fine lines; low contraction
	No. 2 105.7	Lines hardly visible; fairly good contraction
	No. 3 94.0	Fine lines; low contraction
	No. 4 106.0	Lines hardly visible; fairly good contraction
	No. 1 90.5	No lines, good contraction
Steel without molybdenum	No. 2 92.3	No lines, good contraction
	No. 3 89.3	No lines, good contraction
	No. 4 91.9	No lines, good contraction

The elongation, owing to the dimensions of these bars, being meaningless, has not been given.

It will be seen that the ordinary steel gave no streaks, whereas all the molybdenum steel bars presented them. They are barely appreciable in the bars cut from the edges, although they actually exist; they are much more marked in the bars cut along the axis. The dimensions of the ingots being very small and the test-pieces having been cut from the portion corresponding with one-third of the ingot, it was hardly probable that the

difference between the results was due to segregation; it might rather be attributed either to the differences in crystallization—needle-shaped along the edges, equiaxial in the center portion—or simply to some slight porosity of the latter. It will be noted later that microscopic examination of these small samples showed that the metal was practically free from inclusions.

It would therefore appear highly probable that molybdenum, even in small quantities, intervenes to accentuate the bad results of transverse tests.

ATTEMPTED IMPROVEMENT OF MOYLBDENUM STEEL

These tests can be grouped into three categories:

1. Modification of the structure of the ingot by more rapid cooling.
2. Modification of the structure by forging at a higher temperature.
3. Modification, after forging, by reheating and quenching.

FIRST GROUP

Two small molybdenum steel ingots, of the same dimensions and practically of the same composition as the foregoing, were cast, after melting in crucibles, one in the ordinary way and one into an ingot mold plunged into water. The transverse fracture of these two ingots within 40 per cent of the bottom was very sound; that of the ingot cast into the water-cooled mold revealed bacillus-like crystallization going right through to the center, whereas in the other ingot this structure only occupied a superficial zone about 15 mm. thick. After forging the portions representing the 40 per cent lower ends of the ingots, a length of 150 mm. was cut from the bar, and this piece was quenched, annealed and transverse test-bars cut from it as previously described. The fractures of the pieces along the edges showed very fine, barely perceptible lines: those of the central bars were better marked; in spite of the difference in the crystallization the results were identical in both ingots, which shows that the difference in the results given by test-pieces along the edge and those from the center in the previous tests cannot be attributed to this cause, and was probably due to a slight degree of center porosity produced during solidification.

SECOND GROUP

An ingot from basic open-hearth cast No. 930, to which reference has previously been made, was cropped 40 per cent from the top, after which a slice 120 mm. thick was taken and divided into four portions, as shown in Fig. 2. The treatments to which each part were submitted were as follows:

Slab No. 1 was water-quenched from 1,050 deg. and then forged between 950 and 800 deg.

Slab No. 2 was water-quenched from 1,050 deg. and then forged between 1,100 and 950 deg.

Slab No. 3 was given the same treatment as No. 2 above.

Slab No. 4 was unquenched but forged between 1,100 and 950 deg.

The slabs, which were originally 170 x 170 x 120 mm., were reduced by

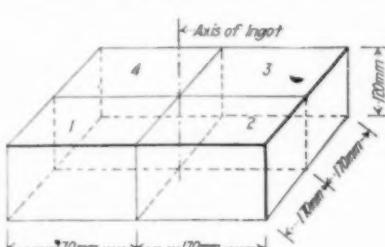


FIG. 2

SUBDIVISION OF INGOT 930

forging to flats, 200 mm. long and 35 mm. in section, their length being parallel with the 120 mm. side—that is to say, with the axis of the ingot. Tensile test-bars were then cut in the directions of the thickness and width of the flats and the results obtained gave rise to the following observations:

First, quenching prior to forging effected no improvement.

Second, the fractures were "woody" whether forging was carried out between 1,100 and 950 deg. or between 950 and 800 deg.; except that the streaks were less marked in regard to the bars from slabs forged between 1,100 and 950 deg.

Third, the differences were fairly marked according to the position from which the test-pieces were cut. Those corresponding with the edges of the ingot were better than those corresponding with parts in the neighborhood of the centers.

Thus, with this ingot, of fairly large dimensions, the same peculiarities occur as in the small ingots of crucible steel cast in the laboratory.

THIRD GROUP

The test-bars were cut transversely from a 75-mm. gun tube forged from an ingot of cast 930, which furnished the slabs described above. They were divided into two groups. Those of the first set were quenched in water from temperatures of 780, 850, 1,000, 1,100 and 1,170 deg. respectively, as soon as the pyrometer showed that the required temperature had been reached. Those of the second group were treated the same way except that the temperature was maintained for one hour before the bars were quenched.

All the fractures showed lines; a slight improvement was, however, detected in the bars kept at between 1,100 and 1,170 deg. for an hour before quenching.

To conclude, it would appear that forging at a high temperature, and that quenching after keeping at a high temperature, will both improve the results, although this improvement is insufficient.

TESTS ON VARIOUS SPECIAL STEELS

During the years 1894 to 1898 a large number of special steels had to be examined transversely in the laboratory, and the conclusion was arrived at that good results could be obtained—the fractures being free from streaks—when the carbon percentage did not exceed 0.25, even with fairly high percentages of the special elements, reaching, for example, in the case of nickel, as much as 7 per cent.

As a result of these conclusions a certain number of casts were made from an open-hearth furnace, some on a basic lining and others on an acid lining. Those made by the basic process showed few or no lines, but side by side with test-bars giving good fractures were others showing small whitish stains, oval and in all probability identical with the defect which has recently been described in various English and American reviews under the name of flakes, which prevented such steels being accepted as suitable metal for guns.

The casts from the acid open-hearth made with all the precautions observed in gun manufacture, such as much slower working of the charge and charging in several relays, gave on the contrary excellent results. Table II gives those obtained on a 75-mm. gun tube forged from an ingot of the first cast made under these conditions. Test-pieces were 13.6 mm. in diam-

eter and 50 mm. long, cut transversely in the middle thickness.

The composition of this cast was: Carbon, 0.24 per cent; silicon, 0.216 per cent; sulphur, 0.022 per cent; phosphorus, 0.031 per cent; manganese, 0.43 per cent; and nickel, 5.55 per cent. The average working was 3:4.

This composition showed that the upper limit of 0.25 per cent fixed for the carbon may be raised to 0.30

TABLE II. TESTS OF NICKEL STEEL FROM ACID OPEN-HEARTH

Treatment	Location of Specimen	Elastic Limit*	Tensile Strength*	Elongation, per Cent	Reduction of Area†
Annealed after forging at 900 deg.	Front	42.7	61.0	24.5	0.460
	Back	43.0	61.3	24.0	0.453
Quenched in water at 900 deg. C. and again quenched at 620 deg.	Front	61.0	82.5	19.0	0.389
	Back	57.7	79.5	23.5	0.468

NOTE—All fractures were what is known in England as "half-cup."

*In kg. per sq.mm.

† $(S - S') / S$

and, even with 5 to 6 per cent of nickel, yield excellent fractures.

A fact that supports the foregoing contention on the subject of the upper limit of the carbon is the following:

During the war tests were made of six breech sleeves from abroad for 155-mm. guns. Five of these pieces had a composition closely agreeing with the above: Carbon, 0.25 per cent; silicon, 0.25 per cent; manganese, 0.50 per cent; nickel, 3.60 per cent; and chromium, 0.80 per cent. They yielded excellent fractures.

The composition of the sixth was: Carbon, 0.34 per cent; silicon, 0.32 per cent; manganese, 0.70 per cent; nickel, 2.76 per cent; and chromium, 0.115 per cent. These bars gave the same elastic limits and tensile strengths as the previous ones, but the elongations and reductions of area were much smaller and the fractures were woody.

TRANSVERSE TESTS ON NICKEL STEELS

The upper carbon limit of about 0.30 need not be kept to as long as the percentage of nickel does not exceed 2.5 per cent. Thus some hundreds of gun-steel casts have been made at Creusot by the acid process with carbon percentages of 0.35 to 0.50 and with 1.8 to 2.4 per cent of nickel, with excellent results when tested in a transverse direction. With more than 2.5 per cent of nickel, however, it is necessary to diminish the carbon in order to avoid woody fractures. This fact appears to the author a strong argument in favor of the hypothesis put forward, namely, that defective transverse results and correspondingly woody fractures may arise, not only owing to the presence of inclusions or blowholes or to overworking, but also owing to the chemical composition of the metal.

It can indeed hardly be doubted that if it be possible to make two casts by the acid open-hearth process, and with every imaginable precaution, one with, for example, 0.25 per cent of carbon and 4 per cent of nickel, and the other with 0.40 per cent of carbon and 4 per cent of nickel, it is more difficult to avoid oxidation and the presence of inclusions in the former than in the latter, yet, however, the former will give good transverse fractures and the second will give streaky fractures even when the treatment has been adjusted so as to give in both instances the same tensile strength on testing.

The latter condition is necessary to afford comparisons, as it may often be found that a steel which in the annealed state does not show a streaky fracture will show streaks once quenching has increased its tenacity. It appears probable to the author that the improvement due to a low percentage of carbon is the result of less segregation around the dendritic crystals formed during solidification, owing to the greater speed with which this takes place.

IMPROVEMENT OF HIGH CARBON-NICKEL STEELS

The program of these experiments was drawn up in order to investigate the influence of percentages of carbon above 0.30, the end temperature of forging, the coefficient of working, and the position of the test samples with regard to the ingot. With these objects, four ingots of 130 x 130 mm. section, and weighing about 75 kg. each, were cast from the crucible furnaces of the steelworks, the lower ends of the ingots being smaller than the tops. Their composition is shown in Table III.

TABLE III. COMPOSITION OF NICKEL INGOTS

No. of Cast	Carbon per Cent	Silicon per Cent	Sulphur per Cent	Phosphorus per Cent	Manganese per Cent	Nickel per Cent
919	0.320	0.272	0.026	0.039	0.480	3.22
924	0.330	0.280	0.026	0.037	0.440	3.30
1004	0.451	0.257	0.030	0.037	0.500	3.25
1005	0.434	0.224	0.028	0.041	0.490	3.22

FORGING

These ingots were forged under a 2,000-kg. hammer. The ingots from casts 919 and 1,005 underwent three reheatings at between 1,075 and 625 deg. C. The other

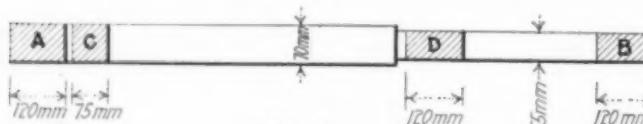


FIG. 3

TEST-PIECES FROM NICKEL FORGINGS

two were forged in five heats at temperatures between 1,050 and 600 deg. Table IV shows the dimensions of the pieces after forging as well as the percentage crops top and bottom.

TABLE IV. FORGINGS FROM NICKEL INGOTS

Cast	Bottom Crop, per Cent	Coefficient of Working 1:4, mm.	Coefficient of Working 1:7, mm.	Top Crop, per Cent
919	6.6	880	540	33.6
924	5.9	870	530	32
1004	5.6	860	460	32.5
1005	5.4	870	400	29.8

After forging the four rounds were annealed at 950 deg. and air-cooled. From each end of each round, a piece 120 mm. long was cut, marked A and B (see Fig. 3). The pieces taken from the bottom end were drilled along their axes with a hole 20 mm. in diameter, and those from the top end with a hole 10 mm. in diameter, in order to secure approximately the same thickness of metal and to be able to obtain smaller bars.

In casts 919 and 924 only, there were then cut, about midway along the length but on the portion reduced to 55 mm., a sample D, 120 mm. in length, and from the bottom end a sample C, 75 mm. long, which was reforged to 55 mm. The forging down was carried out at the same temperature as the first forging, that is to say,

between 950 and 625 deg. for the round from cast 919 and between 1,000 and 900 deg. for the round from cast 924. The lengths obtained were like the previous ones bored with 10-mm. holes.

By acting thus it was possible to determine:

First, the influence of the carbon by comparing the results of the tests of the lengths:

A. Casts 919-1005
B. Casts 919-1005

A. Casts 924-1004
B. Casts 924-1004

These lengths have, in each series, undergone the same amount of working and the same method of forging. They likewise occupy the same relative positions in the ingot. The percentage of carbon is the sole difference between them.

Second, the influence of the end temperature of forging, by comparing the results of the tests of the lengths:

A. Casts 919-924
B. Casts 919-924
C. Casts 919-924

D. Casts 919-924
A. Casts 1005-1004
B. Casts 1005-1004

These lengths had, so far as each series was concerned, undergone the same amount of work; they occupy the same relative positions in the ingot and have practically the same percentages of carbon. They differ solely in respect to the end temperatures of forging.

Third, the influence of the amount of working, by comparing the results of the tests of the lengths:

A and C in cast 919

A and C in cast 924

These lengths have the same carbon percentages and have undergone, in pairs, the same method of forging and occupy the same relative positions in the ingots. The amount of work they have undergone is their sole difference.

Fourth, the influence of the relative positions of the samples in the ingots, by comparing the results of the tests of lengths:

C, D and B in cast 919

C, D and B in cast 924

These lengths have the same carbon percentages; have undergone—as regards each cast—the same method of forging, and have undergone the same amount of work. Their positions, in respect to the ingots, are their sole differences.

All the lengths forged to 55 mm. were machined down to 50 mm., and the 70 mm. lengths were machined

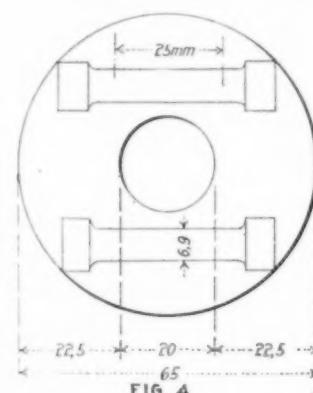


FIG. 4

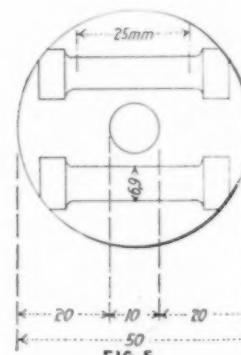


FIG. 5

METHOD OF CUTTING TRANSVERSE TEST-BARS

down to 65 mm., after which they were again annealed at 850 deg. and air-cooled. From each of them a rod 12 mm. thick was then cut for testing before quenching. Each rod furnished two tensile test bars 6.9 mm. in diameter and 25 mm. in length between punch-marks (homologous with those 13.9 mm. in diameter and 50

TABLE V. TESTS ON HIGH NICKEL-CARBON STEELS

No. of Cast	Composition		End Temperature of Forging	Treatment of Bars	Tensile Tests												
	A. Bottom. Working 1 : 4				C. Bottom. Working 1 : 7			D. Center. Working 1 : 7			B. Head. Working 1 : 7						
	Elastic Limit	Tensile Strength	Elongation, Per Cent	$\frac{S-S_1}{S}$	Elastic Limit	Tensile Strength	Elongation, Per Cent	$\frac{S-S_1}{S}$	Elastic Limit	Tensile Strength	Elongation, Per Cent	$\frac{S-S_1}{S}$					
919	0.320	3.22	625°-700°		45.5 66.8 22.4 0.318 43.6 66.1 24.0 0.416	{ 0 39.3 62.3 21.2 0.183 40.5 64.7 21.2 0.237	{ 2 40.8 65.3 18.4 0.232 40.5 64.7 18.4 0.213	{ 2 48.1 65.5 16.0 0.220 48.0 65.4 16.8 0.296									
924	0.330	3.30	925°	Heated to 850°, then cooled in air	43.7 66.3 25.6 0.456 42.4 66.3 23.2 0.392	{ 0 40.2 64.5 24.0 0.362 41.2 64.2 21.2 0.255	{ 1 40.6 63.6 16.0 0.235 39.5 63.8 16.8 0.180	{ 2 43.8 65.2 16.0 0.196 44.0 65.4 16.0 0.194									
1004	0.451	3.25	900°-925°		48.9 76.7 21.6 0.300 50.7 77.3 23.2 0.270	{ 1											
1005	0.434	3.22	625°-700°		47.8 67.8 20.8 0.298 48.2 68.8 20.0 0.273	{ 1											
919	0.320	3.22	625°-700°		60.7 75.5 19.2 0.275 60.2 74.8 13.2 0.138	{ 3 61.8 78.0 14.8 0.240 61.6 77.7 13.2 0.241	{ 2 59.3 76.8 19.2 0.263 60.9 77.1 14.8 0.208	{ 3 59.2 75.3 22.0 0.406 59.0 74.6 23.2 0.424									
					* { 58.4 74.5 16.0 0.247 58.4 74.6 16.0 0.247	{ 3											
924	0.330	3.30	925°		57.0 73.0 18.0 0.198 57.5 72.5 20.0 0.292	{ 2 59.4 74.2 20.4 0.358 58.2 73.1 13.6 0.257	{ 1 58.8 75.0 19.6 0.243 59.4 74.3 13.6 0.213	{ 3 58.8 73.5 20.0 0.267 58.4 73.4 19.6 0.283									
1004	0.451	3.25	900°-925°		70.0 86.2 18.8 0.358 72.0 88.0 18.0 0.320	{ 1 *											
1005	0.434	3.22	625°-700°		54.7 74.9 13.2 0.193 53.4 74.7 16.4 0.245	{ 3											

*Tests made on a second bar. Strengths in kg. per sq.mm.

mm. long between punch-marks). These bars were cut as shown in Figs. 4 and 5.

The rods were subsequently quenched in oil from 875 deg., and in water from 640 deg. A fresh rod 12 mm. thick was taken from each sample and sliced as before.

The accompanying Table V sums up the results of these tests. In the column headed "fractures" the figures 0, 1, 2, 3, 4 and 5 have been used to signify the relative proportion of streaks. Those marked 0 show none; those marked 5 reveal the most.

By instituting the comparisons as already described, so that in each instance there is but one variable, it is found:

First, as regards the influence of the carbon: In eight examples five are favorable to the less highly carburized casts; one gives identical results in both cases, and two favor the more highly carburized casts. It may therefore be concluded, as before, that from the point of view of the test results it is advantageous to reduce the carbon percentage.

[EDITOR'S NOTE:—These figures are compared in Table VI. The author's comparison apparently has to do with the condition of the fracture. Averaging the figures, it appears that increasing carbon from 0.325 to 0.442 per cent increases the elastic limit of an annealed bar 4.4 kg. per sq.mm., increases the ultimate 6.9 kg. per sq.mm., decreases the elongation 2.1 per cent, the contraction 6.5 per cent, and increases the number of streaks in the fracture by about one-tenth. In tempered bars, the higher carbon increases the elastic limit 7.8 kg. per sq.mm. and the ultimate 8.2 kg., decreases the elongation 4.7 per cent, and the contraction 6.5 per cent and increases the number of streaks by about one-fifth.]

Second, as regards the influence of the end temperature of forging, it is found that out of twelve instances six favor high finishing temperatures, three are identical both as to high or low finishing temperatures,

and three favor low temperatures. From this the conclusion can be drawn that it is preferable to finish the forging at as high a temperature as possible.

[EDITOR'S NOTE:—The figures again are compared in Table VII. It appears that in annealed bars decreasing the temperature of forging from 925 to 700 deg. C. leaves the elastic limit and condition of fracture practically unchanged, but decreases the tensile strength, the elongation and the contraction slightly. In tempered bars the results cover a wider range, but their average is nearly negligible, except that the number of streaks is increased about 10 per cent.]

TABLE VI. EFFECT OF CARBON

Bars	Elastic Limit	Tensile Strength	Elongation	Contraction	Fracture
Annealed bars:					
A 919 - A 1005	- 3.4	- 1.9	+ 2.8	+ 0.081	-1
B 919 - B 1005	- 0.4	- 3.7	+ 2.6	+ 0.070	-1
A 924 - A 1004	- 6.8	- 10.7	+ 2.0	+ 0.139	-1
B 924 - B 1004	- 7.2	- 11.4	+ 1.0	- 0.031	+1
Average	- 4.4	- 6.9	+ 2.1	+ 0.065	-0.5
Tempered bars:					
A 919 - A 1005	+ 5.4	- 1.3	+ 1.3	+ 0.008	-
B 919 - B 1005	- 12.2	- 12.6	+ 4.8	+ 0.139	-2
A 924 - A 1004	- 13.8	- 14.3	+ 0.6	- 0.094	+1
B 924 - B 1004	- 10.6	- 5.7	+ 12.2	+ 0.208	-3
Average	- 7.8	- 8.2	+ 4.7	+ 0.065	-1

TABLE VII. EFFECT OF END TEMPERATURE OF FORGING

Bars	Elastic Limit	Tensile Strength	Elongation	Contraction	Fracture
Annealed bars:					
A 919 - A 924	+ 1.6	+ 0.1	- 1.2	- 0.057	-
B 919 - B 924	+ 4.1	+ 0.2	+ 0.4	+ 0.063	-1
C 919 - C 924	- 0.8	- 0.9	- 1.4	- 0.098	+1
D 919 - D 924	+ 0.6	+ 1.3	+ 2.0	+ 0.014	-
A 1005 - A 1004	- 1.8	- 8.7	- 2.0	+ 0.001	-
B 1005 - B 1004	- 2.7	- 7.5	- 1.2	- 0.038	+1
Average	+ 0.2	- 2.6	- 0.6	- 0.019	+0.2
Tempered bars:					
A 919 - A 924	+ 2.2	+ 2.0	- 2.9	- 0.018	+1
B 919 - B 924	+ 1.2	+ 2.2	- 1.4	+ 0.048	-
C 919 - C 924	+ 2.9	+ 4.2	- 3.0	- 0.068	+1
D 919 - D 924	+ 1.0	+ 2.4	+ 0.4	+ 0.008	-
A 1005 - A 1004	- 17.0	- 12.3	- 3.6	- 0.120	+2
B 1005 - B 1004	+ 2.8	+ 9.1	+ 6.0	+ 0.117	-1
Average	- 1.1	+ 1.3	- 0.8	- 0.004	+0.5

Third, in regard to the amount of working the results are indecisive. There are two instances where the 1:4 working is advantageous and two instances where it is the reverse. The author believes this to arise from the small number of tests and, more especially, from the small dimensions of the ingots. [See Table VIII, by the Editor.]

Fourth, from an examination of the results from the bottom, the center and the head of the ingots it results that the bottom portion is distinctly better. The difference between the other portions is inappreciable. [See Table IX, by the Editor.]

Fifth, it should likewise be noted that, generally speaking, the fractures are more woody after quenching than in the annealed bars. Thus, the tests, before quenching, on test-pieces from the bottoms of ingots worked 1:4 show no streaks, although they show them after quenching and annealing.

CONCLUSIONS

To sum up: What this investigation brings out is that forging finished at a high temperature improves the results of transverse tests, although it does not do so sufficiently. Hence, if very good results be sought it is preferable to diminish the percentage of carbon to below 0.30 per cent, if the percentage of nickel has to be increased in order to obtain the necessary tensile strength after quenching.

In addition to the part played by non-metallic inclusions, blowholes and amount of working, in giving bad results in transverse tests of forged parts, it is necessary to take into consideration the chemical composition of the steels and particularly of the percentage of carbon. When this is below 0.30 per cent, and better still below 0.25 per cent, good results are obtained if the metal has been properly made, even when adding a sufficiently high percentage of special metals to secure very high tensile strength after quenching and annealing. This rule applies up to steels which have undergone a 1:8 working, but the author has no experience of higher coefficients of working.

TABLE VIII. EFFECT OF PER CENT REDUCTION

Bars	Elastic Limit	Tensile Strength	Elongation	Contraction	Fracture
<i>Annealed bars:</i>					
A 919 - C 919.....	+4.7	+2.9	+2.0	+0.157	-2
A 924 - C 924.....	+2.3	+1.9	+1.8	+0.116	-1
<i>Tempered bars:</i>					
A 919 - C 919.....	-2.3	-3.0	+2.1	-0.013	+1
A 924 - C 924.....	-1.6	-0.8	+2.0	-0.063	+1
Average.....	+0.8	+0.2	+2.0	+0.049	-0.2

+ Represents advantage of 1:4 over 1:7.

TABLE IX. EFFECT OF LOCATION IN INGOT

Bars	Elastic Limit	Tensile Strength	Elongation	Contraction	Fracture
<i>Annealed bars:</i>					
C 919 - B 919.....	-8.1	-2.0	+4.8	-0.048	...2
C 924 - B 924.....	-3.2	-0.9	+6.6	-0.113	...2
<i>Tempered bars:</i>					
C 919 - B 919.....	+1.9	+2.2	-4.4	-0.085
C 924 - B 924.....	+0.2	+0.2	-2.8	+0.033	-1
Average.....	-2.3	-0.1	-1.0	-0.053	-0.8

It is not necessary to lower the carbon in nickel steels so long as the percentage of nickel is below 2.5. Very good results are indeed obtained with percentages of carbon reaching 0.5, as has been shown by numerous tests on steel manufactured for ordnance.

It would appear that the transverse tests are

improved if the forging of the ingot be wholly carried out at a high temperature, but this improvement is insufficient when the maximum results are required in transverse strength, for example, in the case of steel for guns.

The different tests described in this paper, having been carried out at different times and over a prolonged period, lack the co-ordination they might have possessed had they been carried out as a whole. For this the author offers his apologies.

Growth of Research Associations in England

The formation of combinations or associations of specific trades for the purpose of research work under the British Government's plan, whereby \$4,866,500 is made available for industrial research, continues to become more frequent. Research associations have been formed in connection with chocolate, cocoa, sugar, confectionery, jam, boot and shoe and allied trades, cotton, sugar, iron, motor and allied manufactures, photographic materials, portland cement, woolens and worsteds, scientific instruments, india rubber and tires, linen, and glass industries. The scientific and industrial research department has given its sanction to the formation of similar associations for refractory materials, non-ferrous metals, and Scottish shale oil. Other trades or industries whose applications have been made for the department's approval include launderers, electrical and allied industries, and makers of aircraft. Silk manufacturers, leather trades, master bakers and confectioners, and manufacturers of adhesives have under consideration details of proposed associations.

Before any association can come under the government scheme, the approval of the scientific and industrial research department must be obtained, and subsequently a license must be secured from the Board of Trade. The associations must be national in character and include the bulk of the manufacturers in any specified industry. A legal status is obtained through registration as a company under section 20 of the companies consolidation act, 1918. The associations are limited by guarantee of a nominal sum and may not divide profits; but the contributions of firms, being regarded as business costs, are exempted from income tax. The general scheme is to provide £1 from the department for every £1 subscribed by members up to five years after organization; but should an association's expenditure exceed £6,000 a special arrangement may be agreed to.

At present, the largest associations are those of the cotton and woolen industries. In the cotton association, growers, spinners, manufacturers of loom and knitted fabrics, dyers, bleachers, and finishers are combined; all sections of the woolen trades are represented in the association of woolen industries. With a view to improving supplies of wool, a conference has recently taken place between the woolen association and the Scotch, Welsh, and English sheep breeders.

Origin of the British National Physical Laboratory

At the recent Bournemouth meeting of the British Association for the Advancement of Science, the treasurer, Prof. John Perry, stated that the National Physical Laboratory, the scene of researches of which the importance to the nation during the war cannot be overestimated, had its origin in the Kew Observatory, which was maintained by the Association from 1842 to 1872.

A New Cyanide*

Description of the Process for Converting Calcium Cyanamide to a New Cyanide in a Modern Sodium Chloride Solution—Early European Developments—Recent American Achievements—Products and Production—Applications

BY W. S. LANDIS

ABOUT thirty years ago the new use of cyanide in the gold industry brought to the attention of the chemical world the necessity of producing this material on a larger scale than previously, and at the same time of finding cheaper methods of preparation if the compound was to have an extended use. American, French, English and German chemists attacked the problem most energetically, and from their work arose the present-day processes, with which, as far as they have become commercially practicable, you are probably familiar.

Two German chemists, working on the barium carbonate process about twenty years ago, attempted to supplant the expensive barium salt with a cheaper calcium salt, and obtained a new product, cyanamide, which afterward formed the basis of development of the well-known cyanamide process. To a certain extent they were disappointed at the outcome of their work, as the new product, calcium cyanamide, had little in common with the object of their search, and after its discovery they sought for many years to convert cyanamide into cyanide. Their first patents on this transformation of cyanamide into cyanide were taken out eighteen years ago, these patents covering a process of fusing crude cyanamide with common salt in the proportions preferably of one part of cyanamide to two parts of sodium chloride. The mixture of cyanamide and sodium chloride was to be heated to fusion and until foaming of the mass ceased, which operation was reported to require from $\frac{1}{2}$ to 1 hr. The resulting product was reported to contain cyanide of calcium, but no analyses were given.

In attempting to carry out this process on a commercial scale, apparently they met with a great deal of difficulty. I visited their plant in 1914 and found a great many types of equipment had been installed at one time or another, none of which had worked successfully, and the cyanide plant had been closed down and abandoned for several years.

TYPES OF EQUIPMENT TRIED AND ABANDONED

The earliest type of apparatus consisted of a row of iron crucibles set in a gas-fired furnace with the top flush with the roof of the furnace. These crucibles were about 48 in. deep and 20 in. in diameter and had been made at various times of cast iron, cast steel and welded soft steels. In operation salt was melted in the pot and cyanamide was then stirred in and the whole mass kept fused for a suitable length of time. The transformation efficiencies were extremely low, but no actual record of the same was made public.

The next development consisted in setting two iron crucibles side by side in the furnace. In one crucible they charged salt and melted it, and in the second they charged cyanamide and heated it to redness. Molten salt was ladled from the first crucible to the second, and when a proper quantity had been added the whole mass

was kept melted until by chemical analysis the maximum yield of cyanide had been attained. The contents of the pot were then ladled out and cast into slabs.

The enormous amount of hand labor involved in this operation rendered it commercially impracticable, and a new equipment replaced the old. A revolving furnace was constructed with an enlarged melting hearth midway between the tires. Salt was melted in this hearth and tapped into an iron ladle and conveyed to a crucible containing red hot cyanamide. This operation was also unsuccessful in that there was considerable wear and tear on the salt-melting furnace, and further, great care had to be exercised in pouring the molten salt onto the heated cyanamide, as the initial reaction was very violent and the pot frequently boiled over.

The maintenance of the externally heated crucible at the required high temperature became quite burdensome, and a new type of furnace was developed in which an iron pot, provided with a spout, was set into a fuel-fired furnace. This pot was built of welded flange steel. It was 3 ft. deep and $2\frac{1}{2}$ ft. in diameter. There was also provided an electrode 5 in. square hung on a chain block in line with the axis of the pot so that it could be lowered into the fused mass. In this way a single-phase furnace using about 40 volts and 1,200 amp. was made in a setting also provided for initial fuel firing. In operating, cyanamide was charged into the bottom of the pot and heated to redness by the fire underneath. Salt was melted in the rotating furnace previously described and was slowly poured into the electric furnace at such rate that no very violent reaction ensued. The carbon electrode was then lowered, the current turned on, and the whole mass kept heated electrically until the reaction was complete. The cyanide was tapped through the spout and cast into slabs.

This furnace and process were not successful—the efficiency of nitrogen transformation was very low and the final product contained a comparatively small percentage of cyanide. I was informed, however, that the same type of furnace was being used successfully in another part of Germany, where the salt was melted electrically, and there was being turned out in this second plant a grade of product containing 40 per cent equivalent potassium cyanide at an efficiency of nitrogen transformation of over 90 per cent. I accordingly visited this other plant and was much surprised to find there an entirely different type of apparatus in use.

UNEVEN HEATING CAUSE OF LOW EFFICIENCY

At this second place I found they had tried the combined fuel-fired and electric furnace just described, and had come to the conclusion that the uneven distribution of electric energy throughout the bath caused very uneven heating of its contents, which was believed to be the cause of the poor efficiency obtained from the process. The iron pot would last only two or three runs, due to cracking, and they had abandoned this type of apparatus for a resistance type of electric furnace built

*Read at the meeting of the New York Section of the American Electrochemical Society, Jan. 23, 1920.

of brick. This improved furnace was of the tilting type with a rectangular hearth and arch roof and lined with magnesite brick. The side walls were formed of carbon blocks and electrically connected with a source of current. In practice these blocks were short-circuited with a rod of carbon, and salt was thrown into the furnace and melted around the rod, thus establishing a path of current between the side electrodes. The furnace was then filled with salt. Cyanamide was added to the melted bath and the heating continued until, as shown by chemical analysis, the maximum content of cyanide had been formed, when the molten bath was poured out and cast into slabs. I witnessed several operations of this furnace and found that the furnace produced about 400 kg. of molten product in from 3 to 4 hr. The apparatus used about 21 volts and 2,800 amp. The equivalent potassium cyanide in the final product ran from 8½ to 17½ per cent in the various runs and the nitrogen transformation efficiency from 40 to 75 per cent. During the last run I witnessed, the furnace became blocked with a white spongy material and all operations were abandoned.

It is thus apparent that in the fifteen years elapsing between the initial experiment and my visit the Germans had been able to do little or nothing with the process of transforming cyanamide into cyanide. They had tried out many types of furnaces, none of which was successful in any marked degree, and had produced only a small amount of product of comparatively low grade and at great inefficiency. They were firmly convinced that it would be necessary to use more than two parts of salt to one part of cyanamide in order to make reaction take place at all and that for smooth working at least three parts of salt to one of cyanamide was absolutely necessary, also premixing of the charge was wrong chemically and must not be used. On the basis of these mixtures the final product should test between 15 and 20 per cent of equivalent potassium cyanide. There were many theories and ideas advanced on the subject, but I could find no comprehensive chemical study of the process and little information of scientific value. In fact, the outlook for this transformation was most discouraging.

RESISTANCE FURNACES TRIED IN AMERICA

In the late fall of 1916 there was a sharp advance in the price of cyanide in this country and a great shortage in the available supply. The gold and silver mills of the continent faced a serious situation, and finally one of the large users of the material came to the American Cyanamid Co. with a request that it endeavor to co-operate in producing the necessary requirements of this material. With the discouraging report on the German process in hand and no time available for experimental work, the outlook was not particularly bright, but the problem was attacked and a plant was designed and equipped, using resistance furnaces of a modified design, and the older German procedure was altered somewhat with the hopes of obtaining results at least as good as the Germans had anticipated.

This plant was put into operation at Niagara Falls late in December, 1916. It was provided with five resistance furnaces of a tilting type and two salt-melting furnaces of fixed type. While completing the salt-melting furnaces, the resistance furnaces were put into operation as combined salt-melting and reaction units. They were very much larger than the German furnaces and the design and construction were quite new. They func-

tioned extremely well as such furnaces go, considering the complicated operation. The time of an operation, including salt melting and reaction, was reduced to about 2½ hr., and the salt-melting furnaces were never used for their intended purpose.

Salt, charged cold, was first melted by adding it directly to the hot furnace, the heated walls conducting sufficient current to start the melting. Into this bath of molten salt cyanamide was fed by hand, the bath stirred up with an iron rod, and as soon as all the cyanamide was in, the furnace was tapped by pouring into chill cars. After cooling, the cake was broken up and loaded into caustic soda drums, which formed the shipping container of the final product. Later it was tapped directly into the shipping drums.

IMPROVEMENTS IN THE PROCESS

The process was somewhat troublesome to carry out. The life of the low-grade magnesite brick lining, the only kind then obtainable, was at most six weeks. It then became so conducting, due to the iron content of the bricks being reduced by the cyanide and through its absorption of the cyanide itself, that relining was necessary. Further, the addition of the cyanamide had to be slow and cautious, as considerable foaming took place during the reaction and the contents of the furnace would frequently boil over. The first great improvement was the discovery that the addition of a very small amount of calcium carbide to the furnace would entirely stop the foaming. This permitted the cyanamide addition to be made very quickly, and the power input was, therefore, increased to obtain the additional melting speed. I had learned in Germany that the furnace men over there were of the very fixed opinion that at no time should the temperature of the bath rise above 960 deg. C. or decomposition of cyanide would result. Due to an accident to the electrical system at Niagara one of the furnaces received an undue amount of electrical power in one of the runs and the temperature shot up several hundred degrees above the limit set by the Germans, yet most excellent results were obtained. All furnaces were, therefore, operated at the highest possible temperature, and as a result within three months of the starting of the plant the Cyanamid Co. not only maintained a daily production rate of nearly four tons of sodium cyanide but had carried on experimental work which had enabled it to dispense entirely with the salt-melting furnace as well as some of the reaction furnaces, to cut down the time of reaction to half, to avoid foaming, and further to increase the test of the finished material up to approximately 24 per cent equivalent sodium cyanide.

NEW TYPE OF FURNACE TRIED

The unsatisfactory performance of the tilting furnace led the company to experiment with a new type using a suspended electrode and the combination arc-resistance method of heating. The success following this development enabled it to abandon the numerous small-resistance furnaces and concentrate its efforts in a single unit and at the same time obtain a very greatly improved product. After a short period of development there was constructed at Niagara a single-phase furnace with conducting hearth and a single suspended electrode. This furnace started with an initial capacity of ten to twelve tons of product per day running about 28 per cent sodium cyanide equivalent, but it is now operating at nearly thirty tons of product per day aver-

aging 36½ per cent equivalent sodium cyanide. Additional furnaces are in process of construction.

RAPID DEVELOPMENT OF THE INDUSTRY

The development of the industry has been quite rapid. In 1917 there was produced approximately 2,187,000 lb. equivalent of 100 per cent sodium cyanide. In 1918 this grew to 2,350,000. In 1919 a very considerable revision of the process and equipment was made, and as a consequence the plant operated only seven months, during which period it produced at the rate of over 4,000,000 lb. of NaCN per year. The quality of the product started at about 14 per cent equivalent sodium cyanide in January, 1917, and in August, 1919, ran uniformly between 36 and 37 per cent equivalent sodium cyanide. Material running as high as 50 per cent equivalent sodium cyanide has been produced and there have been shipped several carloads running around 45 per cent, of which I shall speak more later.

The process and apparatus used for manufacturing this product have been extensively described in the many United States and foreign patents covering the process. Essentially, cyanamide, salt and calcium carbide are mixed together and continuously fed to a single-phase furnace designed so that it has a very small cubical capacity as compared with the power input. Melting is extremely rapid and the fused product is removed from the furnace almost continuously to a cooling device, which instantly chills the product. This is necessary to prevent reversion of the initial reaction, whereby calcium cyanamide plus its contained carbon is converted into cyanide. The proportions of cyanamide and salt vary with the product to be made.

In 1917 operations were started with two parts of salt to one part of lime nitrogen and gradually decreased in salt content until, in making the present standard 36 to 37 per cent product, more cyanamide than salt is being used. The large furnace has been successfully operated with proportions as low as two parts of cyanamide to somewhat less than one part of salt, and the experimental furnace with no salt whatever.

THE PRODUCT AND ITS APPLICATION IN THE CYANIDE PROCESS

The resulting product is marketed in the form of small thin scales of a grayish black to shiny black appearance, and the standard grade, known as Aéro Brand Cyanide "Grade X," contains between 36 and 37 per cent equivalent sodium cyanide. This method of expressing its composition is used because it is sold on the basis "per lb. of sodium cyanide equivalent." A constitutional analysis of the material has so far proved impossible of execution, but evidence points to the fact that it consists of a mixture of calcium cyanide, sodium chloride and free lime, with fractions of a per cent each of calcium carbide, calcium cyanamide, and other minor impurities obtained from the ash of the coke used in cyanamide manufacture. The product known as Aéro Brand Cyanide "Grade XX" contains about 45 per cent equivalent sodium cyanide—the cyanogen being actually present as calcium cyanide—a slightly higher percentage of free lime and a materially lower percentage of salt than the X grade.

As to the use of this material, it has found an enthusiastic reception in the mining industry. Being made from cyanamide, one of the cheapest forms of combined nitrogen, and common salt, its cost of manufacture and its selling price are materially less than

the purer forms of cyanide hitherto on the market. The use of caustic soda drums for packing has cut down the expensive item of metal containers forced upon the early industry.

USE IN THE PRECIOUS METAL INDUSTRY

The first of this cyanide made in 1917 went into the precious metal industry after a short series of laboratory tests in which it was demonstrated that it would dissolve gold and silver with equal efficiency to the 98 per cent grade then in the market, and that the accumulation of soluble salts due to the cyclical use of solutions in the mill would not prove troublesome. In mill operations the drums were opened and the cyanide placed in a revolving tumbler which dissolved it in water, thus giving an opportunity for any acetylene produced to be evolved outside of the mill solutions. Containing as it does a small amount of insoluble material, part of which is carbon, difficulty with precipitation due to the presence of this carbonaceous material was feared, and the solutions were therefore filtered before passing into the mill circuit. Experimental work quickly determined that the carbonaceous residue had no precipitating effect upon cyanide solutions of the precious metals, and this early practice of presolution was quickly abandoned and from then to the present time the new cyanide is dumped directly into the mill circuit.

The presence of a small amount of sulphur in the cyanamide is carried through into the cyanide as a sulphide. Difficulty was feared with the presence of this sulphide, but several years' experience has shown that the aeration as employed in the cyanide mills quickly oxidizes these sulphur compounds and renders them harmless. As a result no trouble has been experienced from its sulphur content.

In the gold industry, where the cyanide consumption per ton of ore is comparatively small, no difficulty has ever been experienced with the accumulation of soluble salts. In the silver industry, where cyanide consumptions of not over 5 lb. equivalent potassium cyanide per ton of ore are experienced, they have similarly had no trouble from accumulation of the soluble salts, but where consumptions are considerably above that figure certain difficulties have made themselves known in several of the silver mills. The calcium chloride obtained from double decomposition of calcium cyanide and sodium chloride acts as a precipitating agent and greatly assists in the settling of the mill solutions. Its accumulation in such a solution, however, to an undue extent, particularly in the case where cyanide consumptions run from 10 to 100 lb. per ton of ore or concentrates, leads to a decrease in the available alkalinity of solutions, and steps have had to be taken to eliminate it. These steps consist in the addition of any simple precipitating agent for lime, the precipitated lime being removed in the filter with the mill tailings.

ADVANTAGES OF THE PRODUCT

In every case, either in the laboratory or in the mill, the cyanogen content of Aéro Brand cyanide has proved itself equally as efficient in the extraction of precious metals as that of the 98 per cent sodium cyanide pound for pound of contained cyanogen, added to which are the advantages of a considerably lower cost, slight alkalinity, and the marked influence on the rate of settling of slime in the solution. The new product has found a most favorable reception in the industry and is very widely and extensively used today. In the gold

mills it offers no problem in handling and causes no difference in the practice beyond the fact that the making up of a stock solution is not considered as good practice as the dumping of the cyanide directly into the barren solution along with the ore. In the silver mills, using a considerable quantity of cyanide per ton of ore, simple precipitating methods for eliminating accumulated lime are in use, otherwise their practice is in no way affected.

In its present state of development the new cyanide is not adapted to use in the case-hardening industry or in electroplating. For the case-hardening industry it is very questionable if it has anything to offer in the future, but in the electroplating industry steps are being taken to perfect a method to simply convert it into forms such as the electroplater can conveniently use, and it will undoubtedly make some headway in that industry.

PREPARATION OF CYANIDES, PIGMENTS AND PRUSSIC ACID

For the preparation of cyanides it is a simple matter to dissolve the new product in water, adding sufficient soda ash to eliminate the lime, and filter. It is then ready for precipitation of the various insoluble cyanides.

For the preparation of ferrocyanide it is very satisfactory. A solution of ferrous sulphate is made up of suitable strength, and into this is dumped an equivalent amount of Aéro Brand cyanide and the mass agitated for a short time. Quantitative transformation of the cyanogen to ferrocyanide readily takes place. The insoluble material left in the treatment vat is filtered off, the filtering operation not being very complicated, but the amount of cake to be handled is considerable. The resulting ferrocyanide is then concentrated, and at a certain density about 95 per cent of it will separate out as a meal and the other 5 per cent will remain behind in solution with the chlorides of calcium and of sodium. The meal is separated in a salt filter attached to the evaporator and the solution is thrown away. Recrystallization of the meal with return of mother liquor to the original treatment tank yields a sodium ferrocyanide of remarkable purity. The transformation can be accomplished with not over 5 per cent loss of cyanide.

Recently the manufacture of anhydrous prussic acid from the crude cyanide has been successfully undertaken. Into an acid-proof generator, cyanide and water is charged, the apparatus closed and sulphuric acid run in. A considerable evolution of prussic acid gas takes place, and the solution in the generator is finally cleared of all prussic acid by the admission of live steam. A brine-cooled condenser liquefies the gas evolved from the still and condenses an impure acid containing about 80 per cent prussic acid. This is charged into an iron still and re-evaporated, the resulting condensate being about 98 per cent pure, in which state it is used in fumigating in the citrus-growing districts. The resulting liquefied product is water white and practically chemically pure, at most containing only minute traces of foreign products. The construction and operation of the liquid gas plant, as it is called locally, has been a most successful operation in every way, the only regret being that the installation was not about three times as large as originally planned, because of the great demand for the high quality material it has turned out.

There is no reason to doubt that this new cyanide will find a place in many other chemical industries, as up to

the present time practically no limitations in its use have been found and no chemical properties which prevent its utilization in the many cyanide derivatives.

Quite recent developments have shown the feasibility of manufacturing the higher grade product containing about 45 per cent equivalent sodium cyanide. These developments are too new to present at this time, and a discussion of the process or of the use of the resulting product, which has several new characteristics, will be reserved for the future.

CONCLUSIONS

The development of the process of transforming cyanamide into cyanide marks another triumph of the American electrochemist. We accomplished more in a few months than the foreign chemists accomplished in fifteen years. Three months after starting the designs of a plant our American chemists were producing to the extent of four tons of equivalent sodium cyanide per day of a much higher grade than the Germans had ever hoped for. Within a year we had reduced our operation to a single small electric furnace of a continuous type and produced a product of higher cyanide content than the Germans ever thought possible and at a nitrogen efficiency of over 90 per cent.

The resulting product, of uniform quality and excellent physical characteristics, has found a very increasing market in the various industries using such a product and is today pushing the pure high-grade product steadily out of its long entrenched fields. For the present year the outlook is for a consumption of Aéro Brand cyanide equivalent to nearly 5,000 tons of 100 per cent sodium cyanide. With further development along the lines of transforming this material into its many other derivatives, particularly in view of the very low cost of the raw materials entering into its manufacture, and the simple apparatus and process used, we confidently look forward to cyanide made from cyanamide dominating the world's cyanide market.

Laboratory for New York Department of Health

The Board of Estimate and Apportionment of the City of New York has voted a \$1,000,000 appropriation to construct a new building for the Department of Health. Three or four floors will be given to laboratories. We wonder whether the gentlemen attached to the Board of Health laboratories who have lately joined a labor union will celebrate the completion of the building by a strike. Or if a non-union plumber is called in will they be obliged to quit work? Or suppose, in a threatened epidemic, Dr. Simon Flexner or Dr. Jacques Loeb were invited to come and help. So far as we are aware, despite all their scholarship and achievements, neither of these gentlemen has a union card; and if the laboratories are completely unionized they will become closed shops, whereby both distinguished savants would become "scabs."

Box-Making Course at Forest Products Laboratory

The Forest Products Laboratory is offering a course in box- and crate-making of particular value to superintendents, shipping-room foremen and others of similar qualifications. The course will require one week's time for a fee of \$10. Application for enrollment should be made to the director, Forest Products Laboratory, Madison, Wis. The first week opened Jan. 26, and repetition will be made as often as found desirable.

A Study of the Lime-Soda Ash Water-Softening Process

Observations on the Changes in Alkalinity and Hardness With the Addition of Lime and Soda Ash Separately and Consecutively to Hard Water—Effects of Insufficient, Correct and Excessive Amounts of Reagents

BY MAX R. HERRLE AND FRANCIS M. GLEESON

IN THIS article it is our desire to call particular attention to that branch of factory control relating to the filtering, softening and purifying of water. It is an accepted fact among power plant engineers and users in general that pure clear water is essential for industrial as well as domestic use, and especially that soft clear water for boilers is a great factor in expense saving by reducing fuel bills, repairs and labor incidental to keeping boilers and heaters clean and in first class working condition.

All water on this earth has descended from the clouds at one time or another. This water in its descent has absorbed carbonic acid, air and many other impurities. The carbonic acid absorbed enables the water to dissolve many salts, chief among them being those of lime and magnesium. The common impurities are:

1. Carbonates of lime, magnesium, sodium and potassium.
2. Sulphates of lime, magnesium, sodium and potassium.
3. Nitrates of lime, magnesium, sodium and potassium.
4. Chlorides of lime, magnesium, sodium and potassium.
5. Silica and the oxides of iron and aluminum.
6. Suspended matter, as sand and mud.
7. Organic matter.
8. Carbonic acid.

These impurities are common to all waters to a greater or less extent, and it is their removal that has been the subject of many discussions and writings. There are several methods that are adaptable for the removal of these soluble impurities, and a discussion of their adaptability and practicability will now follow.

THREE CLASSES OF WATER PURIFICATION

In a general sense the subject of water purification may be divided into three classes: Distillation, filtration, and chemical purification by precipitation.

Distillation, although ideal, is too expensive to be considered for supplying large quantities of water.

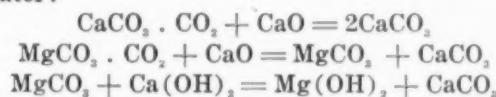
Filtration is of value only when a soft dirty water is to be had, as the dirt will be removed in the process, but should the water be hard due to the presence of soluble impurities, as is the case with most waters, filtration will be of value only after the soluble salts have been converted into the insoluble state.

Therefore, the only method remaining to purify a water for boiler use is chemical purification by precipitation. This method is the one that is used almost universally and the one that will give the best results under the most adverse conditions.

Having discussed the natural substances whose presence in the water supply is detrimental to steam boilers and in other industrial processes, the first thought

which naturally occurs in studying the question is the use of some reagent or process which will effectively precipitate the scale-forming material so that the same may be readily removed before the water is used. The complete softening of a water requires the removal both of its temporary and of its permanent hardness. The temporary hardness of a water is caused by the carbonates of lime and magnesium being held in solution by an excess of carbonic acid. These carbonates, which are practically insoluble in pure water, can be precipitated by removing the carbonic acid. This removal is accomplished by means of lime.

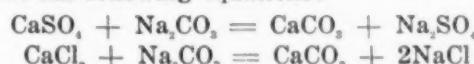
This lime is added as a solution and the following equations illustrate the effect of this reagent upon the raw water:



The lime unites with the acid carbonate of calcium to form the insoluble calcium carbonate, which then precipitates out. It also combines with the acid carbonate of magnesium to produce the insoluble carbonate of magnesium, which is further converted into the more insoluble magnesium hydrate and in turn precipitates out. The lime further effects a practically complete precipitation of the remaining magnesium compounds.

Thus we see that by the addition of lime as a reagent we secure a precipitation of the calcium and a practically complete removal of all of the magnesium compounds because of the fact that the lime removes the carbonic acid which holds the hardness-forming salts in solution.

Permanent hardness of raw water is caused by the sulphates, chlorides and nitrates of calcium and magnesium. Since magnesium compounds have been removed, the remaining permanent hardness of the water is eliminated by means of sodium carbonate, which precipitates the insoluble calcium compounds in accordance with the following equations:



The sodium carbonate unites with the calcium sulphate to give the insoluble calcium carbonate, which precipitates out. The sodium carbonate further unites with the calcium chloride to give the insoluble calcium carbonate.

Thus we see that after the addition of the sodium carbonate all the hardness and scale-forming salts have been removed and only neutral and non-corrosive substances are left in solution.

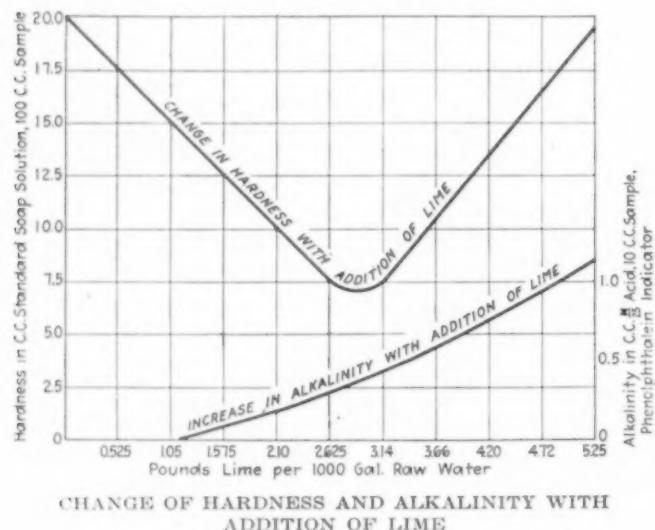
It is now evident that by means of the two reagents, lime and soda ash, an ideal water can be secured with but one problem to face us, that in order to secure this water having a relatively low hardness and alkalin-

ity great care must be taken in adding the reagents. We have carried out a series of tests which we hope will aid in effecting a correct proportioning of the reagents. They are as follows:

Test I. This test deals with the addition of lime to raw water and shows the effect of an insufficient amount of lime, the effect of the correct amount and the effect of an excess.

Test II. This test deals with the addition of soda ash to a raw water and illustrates the effect of an insufficient addition, a correct addition and the effect of an excess.

Test III. This test deals with the addition of both reagents to raw water and shows the correct adjustment of reagents which is absolutely necessary for the production of a good boiler feed water.



Following the tests there is a paragraph dealing with the value of water analysis which also contains the analysis of our raw and treated waters.

TEST I. EFFECT OF LIME (CAO) UPON RAW WATER

A 30-gal. sample of raw water was taken for this experiment. The water had a hardness of 20.0 deg. with standard soap solution and no alkalinity with N/25 acid, using phenolphthalein as an indicator. The water was treated with successive charges of hydrated lime, which was added as a solution by mixing each charge with some of the water of the original sample. After each addition the entire sample was very thoroughly stirred so as to insure a complete and uniform precipitation. The hardness and alkalinity were then tested for as above.

Turning our attention to the graph, it will be noticed that the hardness of the water decreased uniformly after each charge until the hardness of 7.0 deg. was reached, which is the minimum that can be obtained with lime alone. Upon further charging, the hardness increases uniformly but much more rapidly.

The hardness curve may be explained as follows: The hardness decreases uniformly as long as the chemical action between the lime and raw water takes place. When this chemical action is complete the water is at its minimum hardness and any further addition of the lime tends only to introduce an excess of this reagent and increase the hardness and alkalinity of the water.

This conclusion is substantiated when an examination of the alkalinity curve is made. No alkalinity is

observed until the second charge, after which the alkalinity rises uniformly until the minimum hardness is reached, then the alkalinity increases at a greater rate, owing to the excess free lime.

The results of this test were calculated to pounds of lime per 1,000 gal. of raw water to make them of more value to the engineer. Table I will show the amount and the effect of each addition.

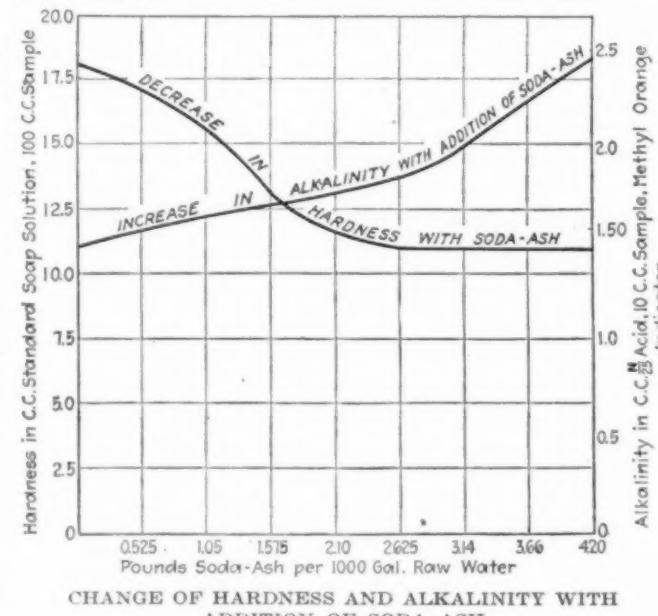
TABLE I. EFFECT OF LIME (CaO) UPON RAW WATER

Lb. Lime per 1,000 Gal. Raw Water	Hardness in c.c. Standard Soap Solution	Alkalinity in c.c. N/25 Acid, 10 C.C. Sample, Phenolphthalein as Indicator
0.0	20.0	None
0.52	17.5	None
1.05	15.0	None
1.57	12.5	0.08
2.10	10.0	0.20
2.62	7.5	0.30
3.14	7.0	0.36
3.66	7.5	0.43
4.20	10.5	0.58
4.72	13.5	0.75
5.25	16.0	0.93
	19.5	1.13

The results of this experiment may be summarized as follows: Sufficient lime should be added to cause the chemical action between the lime and raw water to go to completion, but an excess of this reagent is to be avoided, as it will increase the hardness and alkalinity very noticeably.

TEST II. EFFECT OF SODA ASH (Na₂CO₃) UPON RAW WATER

A second experimental run was made with 30 gal. of raw water, using successive charges of soda ash. The soda ash was added as a solution by mixing each charge with some of the water of the original sample. After each addition the sample was mixed and tested for



CHANGE OF HARDNESS AND ALKALINITY WITH ADDITION OF SODA ASH

hardness and alkalinity, as in the lime experiment, excepting that methyl orange was used as the indicator.

Turning our attention to the accompanying graph, it will be seen that the hardness decreases rapidly after each successive charge until the minimum of 11.0 deg. is reached. This is the minimum that can be obtained with the use of soda ash alone, and marks the point at which the chemical action between the soda ash and raw water is complete. Further addition of soda

ash produces no change, serving only to introduce an excess of the reagent and consequently increasing the alkalinity. An excess of soda ash is not to be feared, as apparently it has no effect on the hardness of the water, although it does increase the alkalinity.

Turning our attention to the alkalinity curve, we see that the alkalinity increases uniformly until the minimum hardness has been reached, after which the sudden upward trend of the curve tells us that an excess of the reagent has been introduced and that no more soda ash need be added.

The results of this test were then calculated to pounds of lime per 1,000 gal. of raw water in order to make them more convenient for the engineer to follow. Table II will show the amount and the effect of each addition of the reagent.

TABLE II. EFFECT OF SODA ASH (Na_2CO_3) UPON RAW WATER

Lb. Soda Ash per 1,000 Gal. Raw Water	Hardness in c.c. Standard Soap Solution	Alkalinity in e.c. N/25 Acid Methyl Orange as Indicator
0.0	18.0	1.45
0.52	16.0	1.55
1.05	15.5	1.65
1.57	13.0	1.70
2.10	11.5	1.75
2.62	11.0	1.85
3.14	11.0	2.00
3.66	11.0	2.25
4.20	11.0	2.43

The results of this experiment may be summarized as follows: Sufficient soda ash should be added so that a slight excess of this reagent remains after the chemical action between it and the water has been completed. The excess will have no effect upon the hardness and but little effect on the alkalinity, so that the engineer need have no fear of its presence. This excess will prove of great value in case the raw water varies in initial hardness, as such small fluctuations can be readily cared for by this reagent.

TEST III. EFFECT OF LIME AND SODA ASH UPON RAW WATER

We have heretofore discussed the effect produced by the addition of lime and soda ash with regard to each curve separately, and now we will discuss the effect of the addition of both soda ash and lime together upon a sample of raw water.

We have found that the addition of lime to raw water produces a minimum hardness of 7.0 deg. by precipitating the soluble hardness-forming salts of magnesium and lime, but other salts of these elements still remain in solution and cannot be removed by lime but will be removed by soda ash.

Now the addition of soda ash to raw water produces a minimum hardness of 11.0 deg. by removing to some extent the hardness-forming salts of lime and magnesium, but other salts of these elements still remain in solution and cannot be removed by soda ash, but will be removed by the addition of lime.

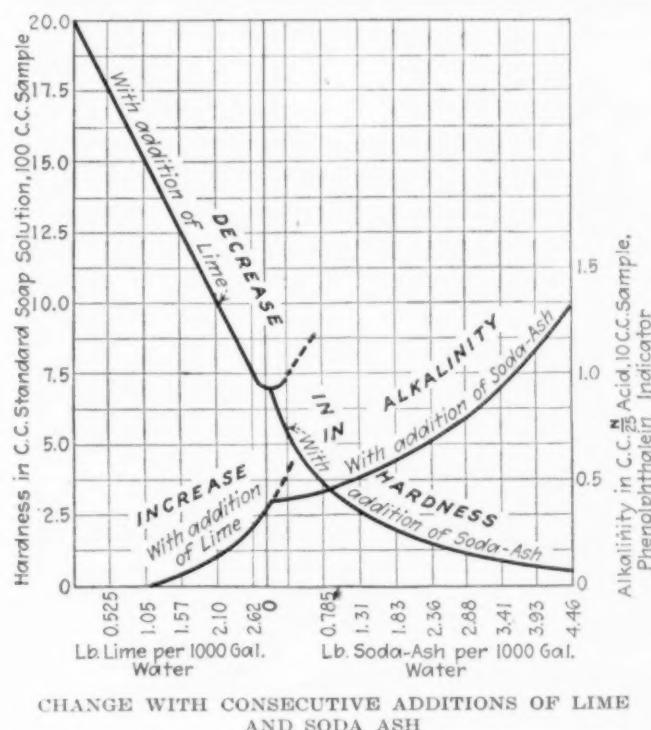
Now it is obvious that by adding both reagents in their proper proportions, theoretically all the hardness-forming salts would be removed and an ideal water result. This is the experiment which will now be carried out to test the value of the theory.

A 30-gal. sample of raw water was obtained as in the preceding experiments and treated with sufficient lime to produce the lowest possible hardness obtainable

with lime alone. This datum was obtained from the lime-water graph. Lime was added first instead of soda ash because an added excess of lime will be cared for by the addition of soda ash later on. The mixture was thoroughly stirred and allowed to set for some time. Upon testing we found that the water had dropped from a hardness of 20.0 deg. to one of 7.0 deg. Now successive charges of soda ash were added, as in the soda ash experiment, and the mixture thoroughly stirred after each addition and a sample taken to be tested as in the previous tests.

Turning our attention to the hardness curve, we find that the hardness decreases rapidly with the successive charges until the minimum of 0.5 deg. is reached, after which no further decrease is obtainable. The theoretical hardness of 0.0 deg. is not obtainable, being probably due to the small sample of water originally treated. In the water-softening system in operation at our plant it is nothing unusual to obtain a hardness of 0.0 degree.

Turning our attention to the alkalinity curve, we find that the addition of soda ash retarded the upward trend of the alkalinity, as indicated by the dotted line, and caused it to rise more slowly until at the minimum



CHANGE WITH CONSECUTIVE ADDITIONS OF LIME AND SODA ASH

hardness the alkalinity is 1.3 deg. This action of the soda ash upon the lime-treated water is very well illustrated in the combination curves which are graphically presented. For instance, an examination of the hardness shows the downward trend of the curve until the minimum hardness due to lime alone has been reached; the dotted curve shows the results of further addition of this reagent. The soda ash begins where the lime has left off and takes the hardness down to its minimum of 0.5 degree.

The same is true of the alkalinity curve. Upon the addition of lime the curve takes a rapid upward trend until the addition of soda ash, when its upward trend is decidedly retarded and a more gradual rise takes place. Table III shows the amount and effect of each addition of lime and soda ash upon raw water.

TABLE III. SHOWING QUANTITIES OF LIME AND SODA ASH IN COMBINATION CURVE

Charge in Lb. per 1,000 Gal.	Hardness in c.c. Standard Soap Solution	Alkalinity in c.c. N/25 Acid
LIME		
0.00	20.00	0.00
0.525	17.50	0.00
1.05	15.00	0.00
1.57	12.50	0.066
2.10	10.00	0.13
2.63	7.50	0.25
2.93	7.00	0.40
SODA ASH		
0.00	7.00	0.40
0.26	5.25	0.41
0.0785	3.00	0.43
1.31	2.50	0.50
1.83	2.00	0.58
2.36	1.50	0.66
2.88	1.00	0.76
3.41	0.75	0.92
3.93	0.65	1.09
4.46	0.50	1.30

THE ANALYSIS OF WATER

As before stated, all water contains soluble impurities to some extent, and, since the removal of these salts is the chief question in the production of boiler-feed water, a knowledge of which salts and the quantity of each is of the greatest importance in determining the amount of precipitating reagents to be used. This knowledge is secured from the analysis of the raw water. By this means the amount of precipitant can be regulated with accuracy.

The table below gives a complete analysis of the water with a hardness of 20.00 before treatment, and of the same water with a hardness of 0.50 obtained in the combination lime and soda ash experiment. The analysis as outlined in Stillman's Engineering Chemistry was followed. The quantities of salts are figured in grains per U. S. gallon.

	Raw Water	Treated Water
Hardness.....	20.00	0.50
Alkalinity with phenolphthalein.....	None	1.30
Silica.....	0.35	0.35
Oxides of iron and alumina.....	Trace	Trace
Calcium carbonate.....	10.04	1.52
Magnesium carbonate.....	5.71	None
Sodium carbonate.....	None	0.23
Calcium sulphate.....	2.72	None
Sodium sulphate.....	None	3.89
Magnesium chloride.....	0.42	None
Magnesium hydrate.....	None	0.39
Sodium chloride.....	1.87	1.58
Sodium hydrate.....	None	0.82
Volatile and organic matter.....	0.60	0.15
Total solids.....	21.41	8.93

The Philip Carey Mfg. Co.,
Lockland, Cincinnati, Ohio.

Influence of Impurities in Lead on Its Resistivity to Acid

C. E. Barrs stated in a paper presented before the December, 1919, meeting of the London Section of the Society of Chemical Industry that lead which contained 0.002 per cent of copper was attacked at 250 deg. C., whereas a sample which withstood strong acid up to 296 deg. was found to contain 0.021 per cent. He concluded that the most satisfactory percentages of copper as regards increasing the resistance of lead to the action of hot acids lay between 0.002 and 0.05 per cent, such lead being able to withstand corrosion up to 280 deg. In the discussion that followed Mr. Lancaster stated that a really pure lead, quite free from copper, will withstand the action of strong sulphuric acid up to 300 to 310 deg. C.

Legal Notes

BY WELLINGTON GUSTIN

Contract Prohibiting Presence of a Given Substance in Ore Does Not Imply Exclusion of Others

PLAINTIFF brought action to recover for the breach of contract by defendant for the purchase of 150 tons of antimonial lead. On affirming a judgment for the plaintiff the Appellate Court held that where defendant contracted to purchase of plaintiff certain "Newark antimonial lead, running approximately from 15 per cent to 18 per cent antimony and not above 1 per cent arsenic," and accepted a certain quantity shipped but refused to accept further shipments unless they were found to be absolutely free from copper, and defendant's witnesses testified no antimonial lead is produced "absolutely free of copper," and there was no evidence that the amount of copper supposed to be in the antimonial lead was sufficient to impair its value or render it unsuitable to defendant's purposes, then defendant's refusal to accept shipments unless found to be absolutely free from copper constituted a breach of the contract for which the plaintiff would be entitled to recover.

Ruling on the effect of a provision in a contract as to the prohibition of a given substance in ore, the court said that the expression in a contract of prohibition against the presence of a given substance in ore sold would, under ordinary canons of construction, exclude any implied exclusion of any other substance. (American Metal Co. vs. U. S. Reduction Co., 205 Ill. App., 492.)

Factory Refuse—What Is Held to Be Polluting Matter—Public Health Paramount

In a suit to enjoin violation of a statute providing that polluting matter shall not be discharged into any stream or suffered to remain upon the banks thereof above the point where a municipality obtains its water supply, the Chemical Co. of America, Inc., was not permitted to plead that the pollution is not perceptible at the municipality involved, because of mitigation in quantity and quality of the effluent; nor that the polluting matter is harmless as diluted, nor that the municipal inhabitants would suffer no inconvenience were their filtration plant of an up-to-date type and properly managed. Nor is it a defense, under the statutes, said the court, that the pollution cannot be traced to spigots in the municipality, the pollution aimed at by the law being at the point of discharge into the stream. (State ex rel. Department of Health of New Jersey vs. Chemical Co. of America, Inc., 107 Atl., 164.)

THE CHARGE AGAINST DEFENDANT

In this action the defendant was charged with discharging factory refuse into the Rahway River, and of depositing such refuse on the river bank above the point from where the city of Rahway takes its water supply, in violation of the statute which provides that "no excremental matter, domestic, factory, workshop, mill or slaughterhouse refuse, creamery or cheese factory waste, garbage, dyestuffs, coal tar, sawdust, tanbark or refuse from gas houses, or other polluting matter" shall be discharged into any river, stream, etc., or placed or suffered to remain upon the banks thereof, above the point from which any municipality obtains its supply of water for domestic use.

Defendant's chemical plant is located at the confluence

of two streams called north and south branches, which empty into the Rahway River about five miles above the Rahway intake. All the liquid waste of the factory was emptied directly into the south branch until 1917, when the municipality of Rahway objected. The chemical company then took measures to clarify the refuse by eliminating the more objectionable matter, the solids, and to store and retain the effluent upon its own premises. Elevated settling basins were installed, and a lagoon was constructed, and later a second and connecting lagoon, into which the effluent from the settling basins is discharged. These remedial steps were taken after consultation with the State health officials and apparently with their approval. However, the progress made and methods pursued were unsatisfactory to these authorities and before the completion of this work the Attorney General of New Jersey asked for an injunction against this alleged pollution.

TOLERATED DURING WAR WORK

From the facts in the case it appears that pollution of the stream was established at a hearing in May, 1918, but as it was not appreciable at Rahway and the defendant was furnishing the Federal Government with an exclusive product for the prosecution of the war, the injunction was withheld at that time. However, the case was retained, with leave to bring the matter on for further hearing if the dike and other devices then under construction failed of their object. After the armistice the State brought up the cause for further hearing, complaining that the efforts of the chemical company to abate the pollution were futile. At that time the dike of the outer or second lagoon had been finished; a moat, of a depth lower than the lagoons and skirting the dike, was dug and connected to sumps, or catch-basins, to intercept seepage, and the sumps were fitted with automatic pumps to force the seepage back into the lagoon. More than that, it appears that before this second hearing came to an end the bed of the south branch was filled up and the stream diverted, so that its nearest point to the lagoon was 150 ft. away, and scientific experiments to neutralize the effluent were under way.

POLLUTING MATTER SEEPS THROUGH LAGOON WALLS

The court said despite this earnest endeavor the lagoons were not watertight, and some of the waste contents still leaked into the streams, polluting them, though perhaps not noticeable or even chemically discoverable at Rahway. A part of the wall of the first lagoon is made up of a pervious railway embankment through which the liquid seeps and runs into the north branch. Other evidences pointed to a time, sooner or later, when the effluent will find an outlet in the new stream bed. That the refuse, the wash of chemical compounds, is deleterious to health and objectionable because of odor, taste and discoloration is proved by the fact that all fish life in the immediate vicinity of the factory was destroyed during the first years of operation of the plant when the flow of waste into the streams was unrestrained.

PLEA NOT GOOD THAT POLLUTION WAS NOT PERCEPTEBLE

Said the court, it was not a good plea that the pollution was not then perceptible at Rahway, nor that the more obnoxious of the polluting matter is nitrobenzol, which to taste and smell is likened unto oil of bitter almonds and sometimes used by bakers as its substi-

tute, or that it is benzaldehyde; nor that to take a poisonous dose one would have to drink more of the water than would be required to drown in. These defenses might be of value were the case one of suppression of a common-law nuisance, but this suit was in aid of the police power of the State and such defenses were wholly beside the issue.

In the amendment of 1918 the Legislature determined that factory refuse and the other mentioned wastes and cast-offs are contaminating, and peremptorily forbade their discharge into streams and their deposit upon the banks thereof. The defendant was violating the law in both of these aspects, said the court. There was drainage of the refuse into at least one of the streams and it matters not if it cannot be traced to spigots in Rahway. The pollution aimed at by the statute law is at the point of discharge into the stream. Further, it condemns not only actual pollution but pronounces as imperatively against the threat and menace of it upon the banks of the streams.

STORING OF LIQUID WASTE ON BANKS OF STREAM A STANDING MENACE

The vast body of liquid waste stored on the banks was a standing menace, the court said. The lagoons cover about five acres and the average depth of the liquid content about 2½ ft. Overflows after heavy downpours of rain, breaks in the dikes from wash or lateral pressure, wastage through fissures in the lagoons, are ever threatening dangers. Then there was seepage at various places in the dike, and other possible dangers. In the circumstances, the confidence expressed by the defendant that it could successfully retain the refuse in the lagoons, and its assurances that it will do so, to the immunity of the water, could not be considered, said the court.

The court also said that the legislative scheme to purify the waters of streams embraced two specific avenues of pollution. One was the discharging of polluting matter directly into the stream, which must include the placing of it on the bank where it must necessarily fall or flow into the stream, and the other was the depositing of it so near the banks as to remain a menace of ultimately reaching the water, contaminating it. "It would be playing with words and trifling with legislative mandate to hold that discharges of polluting matter on the bank anywhere below the brink would be violative of the statute, while a deposit on the bank an inch away from the brink would not be." In another case cited it was then said that no doubt garbage dumps on lands immediately adjacent to the Delaware River, the refuse of which in normal times by reason of the natural slope of the ground found its way into the waters of the river, violated the provisions of this statute.

GOOD FAITH OF COMPANY NOT QUESTIONED

In granting the injunction against the chemical company preventing the discharge of its factory refuse into either of the branches of the river and the suffering of such factory waste to remain on the banks of these streams, the court said that the company had assiduously and in good faith sought to abate the pollution; and as it had prospects of neutralizing the waste, it ought to be given reasonable opportunity to develop the treatment.

This was done, but the costs of the action were put upon the company.

Recovery of Pyridine From Byproduct Coke Ovens*

BY F. E. DODGE AND F. H. RHODES

AMONG the comparatively less important components of coal tar are the so-called "tar bases," pyridine, quinoline, isoquinoline, and their homologues. These tar bases are formed during the coking process, either as primary products from the thermal decomposition of the coal substance or as products of secondary reactions occurring in the gases. When the coal tar is distilled, most of the pyridine and its lighter homologues come over with the light oil fraction; while quinoline, isoquinoline, and the higher homologues of pyridine are concentrated in the carbolic oil. By extracting these oils with moderately dilute sulphuric acid, separating the resulting pyridine sulphate solution from the oil, and liberating the tar bases with an alkali, the crude tar bases may be obtained. From the crude bases pure pyridine or "commercial pyridine" of various grades may be prepared by further purification and rectification. It may be noted in passing that the term "pyridine," as used commercially, is applied, not only to true pyridine (C_6H_5N), but to all of the various tar bases, in somewhat the same way that the term "benzols" is used to include all of the simpler homologues of benzene.

Until fairly recently the supply of pyridine from the coal tar oils, although comparatively small, was sufficient to supply the demand. However, the growth of the American chemical industries which has taken place within the last few years has developed new uses for the pyridine bases, and has greatly increased the amounts required for the purposes for which they were formerly used. The development of the dyestuff industry has created a demand for anthracene and carbazole, and in the purification of each of these products pyridine is used. Light pyridine as a denaturant for alcohol is being introduced to some extent into this country; and some grades of tar bases are finding application as solvents for certain industrial processes. Moreover, recovery of pyridine bases from tar oils is a rather costly process and the pyridine thus obtained is so expensive as to prohibit its use for some purposes for which it would otherwise be suitable. Finally, the tar bases obtained from oils consist largely of "heavy pyridine" (quinoline, isoquinoline, etc.), for which only a comparatively slight demand exists, and contain relatively little of the more valuable light pyridines. In view of these facts it became evident that a larger and less expensive source of light pyridine bases must be developed if the increasing demand was to be met.

COKE OVEN INVESTIGATION

In the development of new sources of pyridine the first problem which presented itself was the determination of the amount of pyridine in the coke oven gases which escaped condensation with the tar. In view of the fact that the lighter pyridine bases have distillation ranges somewhat corresponding to those of benzol, toluol, and solvent naphtha, it appeared probable that a considerable amount of the pyridine formed during the coking was not condensed either in the hydraulic main or in the tar separators, and it seemed logical to expect that a considerable amount of this pyridine would be absorbed and retained by the acid liquor in the am-

monia saturators. Accordingly an investigation of the pyridine balance for the ammonia saturators in a byproduct coke oven plant was undertaken. This work was done by Mr. Dodge and Mr. Rhodes at the plant of the Toledo Furnace Co., at Toledo, and by Mr. Dodge and Mr. Warner at the Clairton byproduct coke plant of the Carnegie Steel Co. At each of these plants Koppers byproduct coke ovens were used. Tar and some ammonia water is condensed in the usual way by passing the gases through hydraulic mains, primary coolers, and tar extractors. Tar-free gas is then reheated slightly and passed through the ammonia saturators, in which the gas is forced to bubble through a saturated solution of ammonium sulphate containing 6 to 10 per cent of free sulphuric acid. Ammonia-free gas is then passed to benzol scrubbers and finally to distributing mains. In the ammonia saturators ammonium sulphate is formed and precipitated from the solution and the solid ammonium sulphate is continuously removed and separated from the mother liquor by centrifuging, while the sulphuric acid concentration of the bath is continuously maintained at the desired point by the addition of the fresh acid. The installations at the two plants were essentially similar, there being only slight differences in form of the individual pieces of apparatus and only minor differences in the operation.

This work showed that a very considerable amount of the pyridine bases formed during the coking of the coal is not condensed with the tar but passes through the primary coolers and tar separators and is absorbed by the acid solution in the ammonia saturator baths. The work showed also that the pyridine sulphate thus formed remained in solution in the saturator bath liquor until the concentration of pyridine sulphate in the liquor reached a certain point, and that further absorption of pyridine by the bath liquor containing more than this critical amount of pyridine sulphate resulted in the separation of a portion of the pyridine sulphate with the ammonium sulphate crystals. For example, it was found that no pyridine could be detected in the salt from a bath containing 2.5 per cent pyridine and that the pyridine contained in a salt from a bath containing 7.5 per cent pyridine was almost one-quarter per cent. The work done at the coke ovens also showed that the amount of pyridine bases not condensed with the tar amounted to approximately from one-tenth to one-eighth of a pound per ton of coal coked.

On the basis of these results it was calculated that the total production of pyridine bases available from coke ovens which are operating in the United States and which use the semi-direct sulphate process is approximately 446,000 gal. per year.

METHOD OF SEPARATION

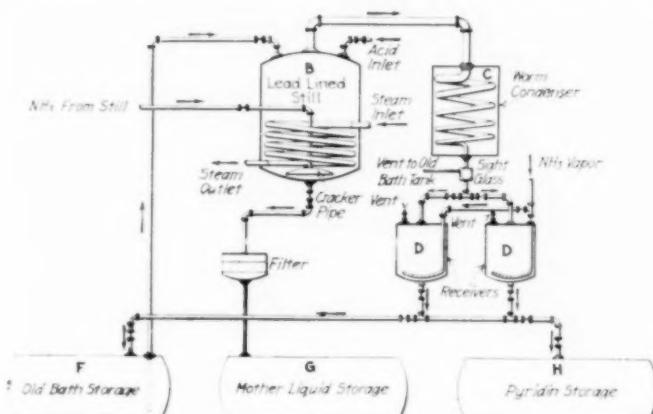
Because of the relatively small amount of bases present in the bath liquor at any one time, and because of the large loss of pyridine which occurred when the concentration of pyridine sulphate in the bath was allowed to rise above a certain very low point, it was evident that any process which would prove economically practicable must not involve the use of expensive chemicals and must not interfere with the normal operation of the plant.

Further investigation showed that if the pyridine-containing mother liquor from the saturator bath is made alkaline by passing ammonia through it, the pyridine

*Read before American Institute of Chemical Engineers, Dec. 6, 1919, Savannah, Ga.

bases originally present in combination as pyridine sulphate are liberated and separate from the saturated ammonium sulphate solution as a distinct layer. It was found, moreover, that if the neutralization of the acid solution was effected rapidly by bubbling through it a gas rich in ammonia, the heat generated by the reaction was sufficient to bring the solution to its boiling point and to steam-distill off the pyridine bases as fast as liberated. On the basis of this work a process for the recovery of pyridine from the ammonia saturator baths was developed and a plant suitable for operating this process was designed and installed in connection with the byproduct coke oven plant at Toledo. The design of this plant is shown diagrammatically by the accompanying sketch.

Tank "F" is a large storage tank for holding the saturator bath liquor before treatment to recover the pyridine bases. This is provided with an outlet to the



hot drain tank, not shown, and with a discharge line leading to the pyridine still proper. "B" is a still in which the saturation of the bath liquor with ammonia vapor is effected. This still is lead-lined and is shown provided with a steam coil for heating the liquor (not found necessary in practice) and with an inlet line for the admission of ammonia vapor. Ammonia vapor required for saturating the bath liquor is taken from the ammonia still operated to concentrate the weak liquor that separates from the gas with the tar. The pyridine still itself is provided with a vapor pipe extending to the condenser and with a discharge line leading through a filter to the mother liquor storage tank. An acid inlet is also provided so that the final pyridine-free liquor may be acidified before being discharged. The mixture of pyridine vapor, ammonia, and water vapor coming from the pyridine still is condensed in the worm condenser "C" and the condensate is collected in receivers "DD," which are provided with discharge lines leading to the pyridine storage tank.

The operation of the plant is as follows: The ammonia saturators are run normally until the pyridine content increases to such a point that pyridine begins to appear in the solid ammonium sulphate as removed from the saturator. When this point is reached the saturator bath is discharged into the old bath storage tank "F" and a new bath is put in operation in the saturator. Sufficient of the material from tank "F" is then pumped to the pyridine still "B" to make a charge. The solution is saturated with ammonia vapor until strongly alkaline. The heat of reaction raises the charge to the boiling point and a mixture of pyridine vapor and water distills over, is condensed, and the condensate collects in the

receivers. This condensate, as thus obtained, carries a considerable amount of water, and before this material is shipped or further worked up for pyridine it is desirable to remove as much as possible of this water. This is effected by agitating the material in the receivers with ammonium sulphate, adding approximately 1 lb. of solid ammonium sulphate for each gallon of distillate. The ammonium sulphate absorbs and is dissolved in the water and the resulting saturated solution separates to the bottom of the receiver, leaving an approximately dry pyridine as the upper layer. The ammonium sulphate solution is allowed to settle and is drawn off to the old bath storage tank, while the dry pyridine bases are drawn off to the regular pyridine storage tank.

It has been found that when the old saturator bath is made neutral or alkaline by the passage of the ammonia vapors a blue or bluish black precipitate is formed. This precipitate consists apparently of finely divided free carbon or of a mixture of free carbon with ferro- and ferri-cyanides of iron. In order to remove this precipitate the liquor from the still is filtered through a small filter. The filtered liquor is then stored in the mother liquor storage tank "G." This filtered, pyridine-free liquor may be charged directly to the ammonia saturators as a fresh saturator bath. We have found, however, that this filtered mother liquor may be used to very good advantage as a wash liquor for washing ammonium sulphate crystals in the centrifuges as they come from the saturator baths, since by using this liquor in this way it is possible to wash the crystals free from adhering impurities without incurring any danger of solution of the crystals.

It will be observed that this process involves a minimum amount of handling of various solutions. Moreover, no material is used which is not available in large amounts at any byproduct coke oven plant, and the process as outlined does not interfere in any way with the normal operation. Finally, the only materials which are used in this process are ammonia and sulphuric acid and all of the ammonia and all of the sulphuric acid thus used are recovered as ammonium sulphate by the normal operation of the plant.

The plant erected at Toledo was on a semi-experimental scale only and the production has not thus far been very large. However, several hundred gallons of pyridine bases have been produced at this plant and the results obtained appear to be very encouraging. The pyridine which has been produced has been essentially a crude, light pyridine, distilling very largely below 200 deg. C. The water content has varied considerably, although several of the lots have shown only a trace of water. This pyridine as produced appears to be a very satisfactory crude pyridine for the preparation of refined pyridine bases for denaturing and chemical purposes. The extension of this process to other and larger coke oven installations should afford a supply of light pyridine bases adequate to the present or the immediate future needs of the country.

Since the development of this process a new and very interesting aspect of its application to the byproduct coke oven industry has appeared. As is well known, the presence of pyridine is objectionable in sulphate of ammonia. The use of this pyridine recovery process in conjunction with the semi-direct ammonium sulphate process insures the absence of pyridine sulphate in the ammonium sulphate produced, which is very desirable from several points of view.

Electrical Precipitation in Japanese Smelters

BY DR. RITARO HIROTA AND KYOSHI SHIGA

A NUMBER of electrical precipitators have been installed in Japanese smelters since 1918 by the Metallurgical Research Institute, which owns the Japanese rights of the Cottrell process. These plants are all quite similar, consisting of from one-half to ten repeated sections, each containing sixty-four pipes, 12 in. in diameter and 16 ft. long (30.5 cm. x 4.9 m.) of cross-section shown in Fig. 1. Ordinarily one motor-generator set serves two sections, each set comprising a 15-hp., 50-cycle, 500-volt, three-phase motor, a 10-kva., 50-cycle, 200-volt generator, and a 10- or 15-kva. transformer capable of giving 100,000 volts on the secondary. Details of the various installations given below are taken from a pamphlet issued by the Metallurgical Research Institute.

ASHIO SMELTER, FURUKAWA MINING CO.

There were two treaters installed in 1918: one, which is called the main treater, was intended to treat the mixed gases from four McDougall roasters, two copper blast furnaces and four converters; and the other, called the reverberatory treater, was intended to treat the

mixed and treated entirely by the main treater. Thus the gas volume now handled by the main treater seems somewhat in excess of 150,000 cu.ft. per min., as designed. The amount of dust collected varies from six to ten tons per 24 hr.¹ The efficiency of precipitation seems to depend upon the nature of the furnace charge and the moisture and temperature of the gases treated. When the conditions are very favorable, it runs as high as 98 per cent, passing a white smoke, but sometimes it drops to about 70 per cent, when the smoke acquires a yellow tint. When the conditions are such that the charging voltage can be raised above 80,000 volts with a comparatively small increase of the current, precipitation is very satisfactory.

Several years ago a large dust chamber was installed, using the Roesing wire system. The gases passed from this chamber to four large stacks, in which they were diluted by the forced admission of fresh air, before being discharged into the atmosphere. The main treater was installed at the side of this dust chamber, so the gases pass through the dust chamber before going through the treater. The numerous suspended wires in the dust chamber were removed, so that only the heavier dust, which is of more value because of its higher percentage of metals, would be caught in the chamber and all the lighter dust which cannot be efficiently collected by gravity settling would be caught in the Cottrell treater.

An analysis of one of the samples of the Ashio main treater precipitate is as follows:

	Per Cent	Per Cent	
Cu	1.37	Al ₂ O ₃	1.45
Fe	2.99	As	31.83
S	19.72	Pb	0.84
SiO ₂	3.92	Zn	5.57
CaO	1.19	Moisture	6.40

As the analysis shows, the precipitated dust contains rather large quantities of the oxides of arsenic. These oxides are extracted by subliming the dust in a small reverberatory furnace, and the cinders resulting, which are quite rich in copper, are sent back to the pot roasters after being briquetted.

KAMIOKA SMELTER, MITSUI MINING CO.

The gases passing through the treater come from the following furnaces: Three lead-smelting blast furnaces, two liquation furnaces, five softening furnaces, and all the lead-refining furnaces and kettles. The Kamioka Smelter is located in the heart of the sericulture district, and the residents in the vicinity made strenuous objections and demanded heavy indemnities, claiming that the smelter smoke damaged the mulberry leaves and killed the silkworms. Therefore, every effort was made to complete and start the Cottrell plant at an early date. About 1 to 1½ tons of dust are collected per day in a three-section treater.

Analysis of the precipitate is as follows:

	Per Cent	Per Cent	
As	19.65	Free S.	1.13
Pb	57.26	SO ₄	0.63
Cu	Trace	Zn	1.68
Bi	0.16	Ag	0.0063
Fe	0.16	Au	Trace
Total S.	5.91	Insol. residue	0.31
		Moisture	0.90

NAOSHIMA SMELTER, MITSUBISHI MINING CO.

The erection of this smelter was permitted by the government on the condition that the smelter gases would be cleaned by the Cottrell process. The operation of the treaters (Fig. 2) was therefore begun when

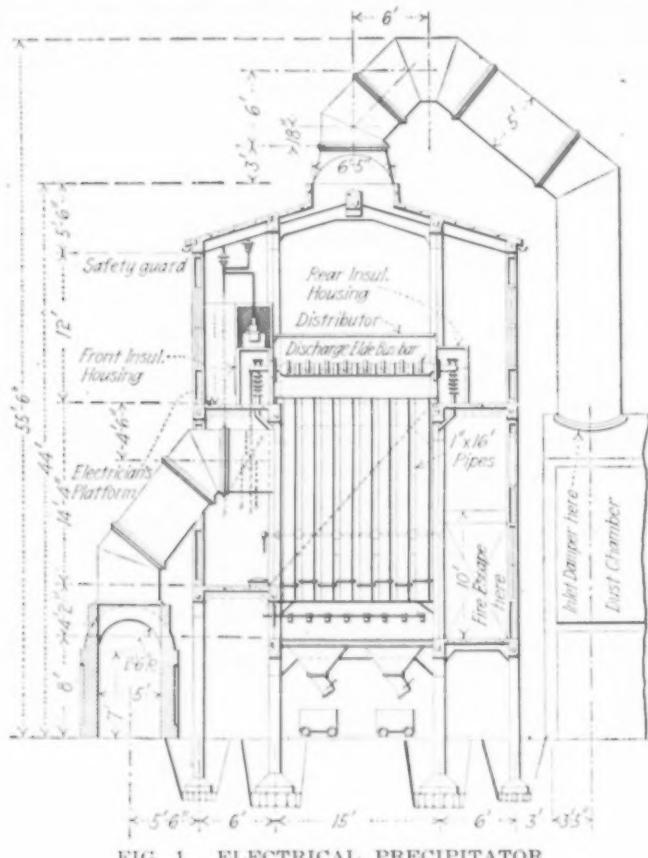


FIG. 1. ELECTRICAL PRECIPITATOR

gases from a reverberatory furnace after having passed through waste-heat boilers.

The gases are drawn through the main treater and discharged directly from the fan casings, while those of the reverberatory furnace are drawn through the reverberatory treater by the natural draft of the stack. As the reverberatory furnace is not operating continuously at present, the gases and those of eleven pot roasters, four blast furnaces and four copper converters are

¹Long tons—approximately equivalent to metric tons—are used throughout this paper.

the smelter started up in March of 1919. It was designed for a capacity of 80,000 cu.ft. per min. (2,300 cu.m. per min.), assuming a velocity through the pipes of 5 ft. (1.5 m.) per sec. The lead-bearing fumes from the lead-smelting furnaces and the fumes from the McDougall roasters and converters of the copper smelter are mixed, and are both treated by the precipitator. Natural draft is furnished by a stack 150 ft. high and 10 ft. inside diam. (45.7 x 3.05 m.).

The smelter being only recently started, the furnaces are not yet running at their full capacity and the gas

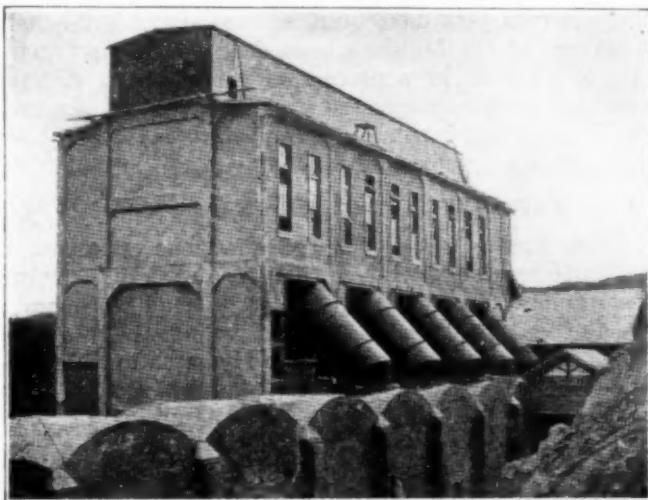


FIG. 2. TREATER AT NAOSHIMA SMELTER

volume handled runs from 40,000 to 45,000 cu.ft. per min. (1,100 to 1,300 cu.m.) Visual clearance by an S-section plant is practically perfect.

The dust collected every 24 hr. amounts to about 1.5 tons, and its analysis is as follows:

Per Cent	Per Cent
Cu	2.30
Pb	22.54
Fe	11.20
S	12.00
As	13.43
Au	Trace
Sb	3.14
Zn	3.29
Loss on heating	25.68
G/Ton	
Ag	100

IKUNO SMELTER, MITSUBISHI MINING CO.

The treater at the Ikuno Smelter handles the gases from two blast furnaces smelting copper ores. After passing through an old dust chamber, the gases are drawn through the treater by an exhaust fan and are discharged from the old stack. At the first trial the treater showed good efficiency, but this lasted only a couple of days and then the operation became so unsatisfactory that the diminution of smoke could scarcely be recognized even when the treater was charged with a high potential. After experimenting in various ways, it was decided to humidify the gases, a practice which was found necessary for satisfactory precipitation in several American plants. A dozen orchard spray nozzles of $\frac{1}{16}$ -in. diameter (1.6 mm.) arranged in the dust chamber using water at 120 lb. pressure per sq.in. (8.4 kg. per sq.cm.) injected a fine spray into the gases before they entered the treater. Thus precipitation was conspicuously improved and the efficiency raised to about 95 per cent, and at the same time the operator can raise the charging voltage to 80,000 volts while the current is only 30 amp. When, in order to examine the effect upon precipitation, the water sprays are turned off, the charging potential drops and the current increases so that the clearance becomes as low as 50 per cent.

The amount of dust precipitated per 24 hr. is about 0.6 ton, and its analysis is as follows:

Per Cent	Per Cent
Ag	0.0007
Pb	7.80
Cu	0.50
Bi	2.48
Fe	1.01
Al ₂ O ₃	0.20
Zn	6.80
CaO	0.30
MgO	Trace
As	32.39
Sb	Trace
Sn	10.80
SiO ₂	1.05
S	12.17
SO ₃	6.78
H ₂ O	5.40
C, etc.	12.32

NIKKO ELECTROLYTIC COPPER REFINERY, FURUKAWA MINING CO.

Here the gases from two cupellation and two reduction furnaces are treated to recover silver-bearing lead dust. The treater consists of one section of 32 pipes, arranged in a rectangle 8 x 4.

The treater was started in May, 1919. The analysis of the precipitated dust is as follows:

Per Cent	Per Cent
Au	Ni
Ag	Pb
Cu	Se

The amount of the precipitate is about 100 lb. (45 kg.) per 24 hr. The power consumption is comparatively high, being from 2.5 to 5 kw.

Scottish Oil-Shale Possibilities

H. M. CADELL read a paper before a recent meeting of the Mining Institute of Scotland in which he discussed the origin of their important oil-shale beds. He said that all really competent authorities were at one in ascribing mineral oil to an organic source in the shape of vegetable or animal remains embedded in certain strata, the decomposition of which had produced solid or liquid hydrocarbons or natural gases. The origin of the oil in the shales had been explained in two ways.

ORIGIN OF OIL SHALES

The most natural explanation is that the shales were originally beds of fine silt or clay, deposited in lakes or lagoons near the shores of a carboniferous land area, and the impalpable mud was mixed with a large quantity of vegetable or animal matter, like the black vegetable slime that was washed off a peat moss. During the carboniferous period vegetation was luxuriant, and there were both forests and peat mosses, the debris of which might easily be washed away and deposited in the adjacent lagoons round the coast, or in land-locked basins where the water was tranquil. The vegetation mud in the oil shales formed a more or less uniform impervious stratum, and each seam originally covered a wide area—more than 100 sq.mi. in extent. The uniformity in composition and the extent of the shales was remarkable, and could only be explained by a long-continued deposit of fine silt under steady conditions of climate and topography.

ANOTHER THEORY

The second of the theories supposed that the shales were not originally petrolierous at all, but were merely receptacles of oil that had been injected or "inspissated" into them in some manner from some oil-bearing reservoir in the vicinity. However, so-called oil shale does not contain oil or oil matter at all. It contains a substance called kerogen, which is not oil or bituminous in nature, but at once turns into oil when heated to a certain temperature. In some cases the shales have been invaded

by igneous rock, which had once been hot enough to raise them to the temperature that would distill the kerogen and produce oil on the spot, but except at such places the kerogen remains unaffected. It appears obvious that the igneous invader had not an excessive temperature, because in most cases the surrounding rocks, if affected at all, show only the effects of the heat for a few feet or inches from the edge of the whinstone mass. The Scottish shalefields are therefore in more likelihood a potential oilfield that had been arrested in its infancy for want of the kindly warmth in Mother Earth that was required to turn kerogen into liquid hydrocarbon, but which had produced the finished article in more favored locations.

ESTIMATES OF OIL-SHALE RESOURCES

Other interesting material on the same subject is abstracted in the *Iron and Coal Trades Review* for Oct. 24, 1919, from the 1918 "Summary of Progress of the Geological Survey," containing a series of estimates of the oil-shale resources. In preparing these, all substances except oil-shale have been excluded, though oil can be obtained, and has been produced in Scotland on a small scale from cannel coal, torbanite or bog-head, parrot coal and parrot shale, peat and ironstone coal. As regards the thickness and quality which render a shale workable, it was decided to adopt as a standard the conditions which existed in the Scottish oil-shale industry during the ten years preceding the war. Accordingly, shales less than 3 ft. in thickness have been excluded, except in a few cases where their high quality or other favorable conditions have proved them to be of practical value. Also those areas have been excluded where the oil-shale, though present, is known to be of no practical value.

A rough approximation only to the amount of oil likely to be obtained from the oil-shale reserves by distillation is possible. A shale yielding a large quantity of ammonium sulphate can be distilled at a profit, even though it produces only 19 gal. of crude oil per ton. The richest shales yield 60 or 70 gal. per ton. In the Reports of the Mining Inspectors of recent years, 25 gal. of oil per ton is given as the average figure.

As regards depth, 300 fathoms (1,824 ft., or 556 m.) has been taken as the present limit, for it happens, from the geological structure of the shale-fields, that the oil-shale resources below that depth are not large and would not greatly affect the totals obtained. Moreover, there are no bore-records which can serve as reliable indications of the occurrence, thickness and quality of these deep-seated shales. The limit has hardly been reached by the deepest shale mines.

CONSIDERABLE NUMBER OF SHALE SEAMS WORKED

The number of shale seams that have been worked in Scotland is considerable. Nearly all of them lie below the Scottish carboniferous limestone. The principal shales are, in downward order, the Raeburn, Mungle, Fells, Broxburn, Champfleurie, Dunnet, Camps, and Pumpherston shales. Of these seams, the more important, such as the Broxburn, Dunnet and Pumpherston, may form a series many feet in thickness, which is separated into bands of good oil-shale with barren shale or blaes between, and each band may have a separate designation. In no district are all the shales present in workable development: often at the horizon of an oil-shale only a carbonaceous shale or shaly blaes is met with.

The horizon is generally recognizable in the bores by the presence of some equivalent bed, or the oil-shale may be there but too thin to work. Oil-shales seem to be much more variable than coal seams in these respects. It is noteworthy also that they do not pass laterally into coal seams, but into dark carbonaceous shales yielding little oil.

Each of the important oil-shales is confined, as regards its maximum development in thickness or quality, to one or more areas, and in no one area is it usual to find more than three or four of the oil-shales in satisfactory condition. The numerous masses of intrusive igneous rock that have been injected into the oil-shale measures of the Lothians have destroyed a vast quantity of oil-shale by a process of subterranean distillation, and unfortunately the principal oil-shale seams—the Broxburn, Dunnet, and Pumpherston—have all been extensively subjected to this action.

FUTURE OF SCOTTISH SHALE-OIL MINING

Other factors, not geological, affect the estimates of workable reserves. A shale that was unworkable before the war may, by changed commercial conditions, prove to be of value. As an example, the Pumpherston shales, which are comparatively poor in oil but rich in ammonia, were once practically valueless, but now are of great importance. The future of shale-oil mining in Scotland would seem to depend principally on two factors—the rates of wages and the prices obtained for shale-oil products (oil, paraffine wax, and sulphate of ammonia)—and any changes in these will directly affect the magnitude of the payable reserves of oil-shale.

Since 1873 the output of the oil-shale from Scottish mines has been reported each year in the Home Office returns. From 1873 to 1917, inclusive, it amounted to 89,401,981 tons, or, say, 90,000,000 tons.¹ The rise of Scottish oil-shale mining dates approximately from 1862, when the Torbanehill mineral was exhausted, and an allowance of 10,000,000 tons is more than sufficient to cover all mining before 1872 and also the output for 1918 (not yet published). This gives 100,000,000 tons as approximately the amount of shale that has been mined. To this must be added the amount lost in working from a variety of causes, say in the neighborhood of 20 per cent, or 20,000,000 tons; giving a total of shale mined 120,000,000 tons.

RESERVES AND PRESENT OUTPUT

The estimated reserves for the oil-shale fields are as follows:

	Proved and Probable, Tons	Possible, Tons
Midlothian	163,497,000	356,120,000
Linlithgowshire	416,539,000	371,211,000
Lanarkshire	16,730,000	67,000,000
Peebles-shire	5,120,000	28,020,000
Fifeshire	61,440,000
	601,886,000	883,791,000
Deduct amount already worked as above	120,000,000	
Total still available	481,886,000	

Practically all areas where igneous intrusions are known to occur on or near the horizon of an oil-shale have been omitted from the estimated reserves.

At present the output is approximately 3,000,000 tons a year. Adding 20 per cent for loss in working we get 3,600,000 tons as the yearly depletion of reserves. This indicates 133 years as the duration of these proved and probable reserves at the present rate of working.

¹A metric and long ton are practically equal.

Air Conditioning in the Industries

BY E. E. LEASON

AIR conditioning is becoming recognized as a subject of increasing importance by those who are interested in atmospheric conditions in factories, mills, laboratories, bakeries, tanneries, and the like, because the proper conditioning of air not only aids manufacturing processes but gives employees the proper air to breathe.

The possibilities of overcoming unhealthful air conditions are multitudinous. Among the most pronounced examples are chemical laboratories, bakeries, confectionery factories, film manufacturers' laboratories, lithography and printing plants, textile mills of all classes, and hide and leather establishments. The possibilities, however, of conditioning air are by no means confined to the industries just enumerated. Wherever there is "sick" air there is a remedy.

SPECIFIC EXAMPLES

To be more explicit about the application of air conditioning systems, a few specific examples may be considered. For instance, in dye houses where no air conditioning system is installed the amount of fog or steam may be so great that a light will not show through it more than 30 in. away. The drip from the roof in such a room is a nuisance and the drops of water collecting on the roof soon cause decay and deterioration. Furthermore, in a number of chemical industries the materials used are highly hygroscopic. This is true in the manufacture of gelatine products and explosives where it is imperative that constant comparatively low temperatures and constant low moisture content be maintained. In other processes, those which involve oxidation, it is necessary that constant atmospheric conditions be maintained in order that the oxidation may be regular and rapid. This occurs more particularly in processes which involve the use of varnishes and paints.

Air conditioning is also a prime factor in the regulation of conditions in laboratories or manufacturing plants where very delicate tests are made. Balances which weigh to the fifth or sixth decimal place are affected by variations in atmospheric conditions. It is evident, by eliminating these variations, that tests, no matter how far apart, can be accurately compared.

IN CANDY FACTORIES

In candy and chocolate factories, cool, dry air is an absolute requirement. If hard candy is kept in moist air for even a short period before being wrapped or hermetically sealed, the product loses its transparent color and resolves again into the appearance of granulated sugar; also the moisture makes the candy sticky and any particles broken off in the process of manufacture become affected in the same way. Automatic machinery is gummed up and eventually the whole factory must be closed down due to the fact that the machines cannot be run. If, however, moisture is taken out of the air and it is kept at a comparatively low temperature, the candy remains indefinitely as it was originally made and the particles are as so much dust which may be collected by a vacuum cleaner, as it will be a dry sand-like powder. Chocolate candy which is made in warm moist rooms assumes the familiar gray color due to the working of the cocoa oils. In this

industry, too, uniform low temperatures and low moisture content are prime necessities.

IN THE BAKING INDUSTRY

It is found that in the baking industry, a high humidity at a proper temperature maintained throughout the year will insure the baker standardized time for the rising of the dough. This is most essential where all baking and handling is done by machinery and thousands of customers wait each day for their fresh bread. The relief of a baker whose dough is ready for baking every day at the same hour can readily be imagined. The profit that results from having the bread ready at a specified time each day as compared to losses resulting from irregularity in deliveries makes an air-conditioning installation a paying investment.

IN PHOTOGRAPHY

Manufacturers and users of photographic films are being greatly helped by the proper conditioning of air. Films are made by a gelatine process and are therefore not only hygroscopic, but are soft and melt in warm humid air and must be dried at a low temperature and low humidity. Without manufactured air conditions the film manufacturer must depend upon favorable natural weather to produce films. Frequent forced shutdowns result because the weather is too hot or too damp. With artificially controlled atmospheric conditions, manufacturers of moving picture films, photographic paper and dry plates can operate 365 days in the year.

LITHOGRAPHING AND COLOR PRINTING

Successful lithographing and color printing where more than one color is used is dependent on air conditions. One of the most important points in work of this kind is the registering of the various colors so that they blend with one another. Every one has seen pictures where this registering was not perfect. This results almost entirely from the expansion and contraction of the paper due to variations in moisture content in the printing room.

IN OTHER LINES OF INDUSTRY

In the textile, paper, chemical and drug, and meat industries, the maintenance of constant moisture content is a great factor of profit or loss. In these industries the manufacturers must protect their materials against loss of weight by loss of moisture. If textile fabrics, for instance, are allowed to become dry and are sold in the dry state, the manufacturer will lose a startling amount of money in a year. With cotton and wool at present prices one cannot buy the raw material with 12 per cent moisture in the case of wool and sell finished cloth with 4 or 5 per cent without taking a loss that would more than pay for an air-conditioning installation.

Furthermore, in the textile industry, silk, cotton and wool, static electricity is a source of constant worry to the factory superintendent, especially in winter. As the fibers pass over the machines, friction develops which causes the fibers to repel each other so that a close-spun thread or yarn with the fibers lying parallel does not result, producing, thereby, a product of inferior strength and resulting at the same time in the formation of a great deal of "fluff" or "fly." This "fly" floats around the room and is breathed by the operators. The way to overcome this condition is to add

enough moisture to the air to make it a favorable conductor of electricity so that as soon as a static change is formed in the product, it is drawn off and dissipated. Further, if enough moisture is present, the particles of "fluff" absorb moisture, become heavy and settle to the floor, where they may be readily swept up.

Equipment for air-conditioning is manufactured by the B. F. Sturtevant Co., Boston, Mass. Supplementing the manufacture of this apparatus the engineering organization of W. L. Fleisher, Inc., of New York City investigates industrial atmospheric problems.

Rennerfelt Electric Reverberatory Furnace

BY H. A. DE FRIES

THE Rennerfelt Electric Reverberatory is based on U. S. patent 1,313,834, of Aug. 19, 1919, covering generation of electric heat by means of arcs drawn between vertical electrodes and a conducting bed located horizontally within the furnace. The rays of the heat thus generated strike the melting chambers not only directly, but also indirectly, by reverberating downward from the roof, if it is given the proper curvature.

A wide range of temperatures can be obtained by shortening or lengthening the arcs formed between the electrodes and the conducting bed, and it is also possible to obtain a smothered arc by bringing the electrodes in direct contact with this conductor. In the latter case the same conditions will prevail as in ordinary fuel-fired reverberatories. These arrangements tend to give the furnace a wide range of applications to various processes, such as the smelting of ores, reduction of chemicals, distillation processes, bullion smelting and melting, refining of copper, etc., and also melting of all of the non-ferrous metals and alloys. The construction of this furnace is made as simple and cheap as possible.

From the illustration it will be seen that the furnace is of rectangular shape, built of common firebrick, retained within a reinforced steel box for the smaller sizes and held together with buckstays, skew-backs, etc., for large capacities. The smaller sizes can be made tiltable, whereas the large furnaces will always be sta-

tional. The roof is also of common firebrick and can be built stationary or removable as occasion may require. The electrodes enter through this roof vertically and the number of electrodes depends principally on the characteristics of the current, but to some extent also on the size of the furnace.

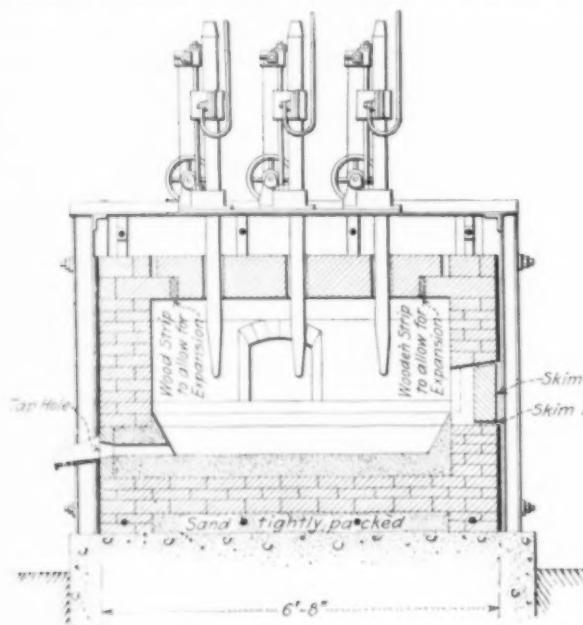
When three-phase current is available, the number of electrodes should be three or a multiple of three. In case of two-phase current, the number is two or a multiple of two. If only single-phase or direct current is available, the power is divided between two or more electrodes.

The bottom of the furnace contains the conducting bed. This bed consists of a carborundum trough in 2-ft. sections placed on a brick pier running lengthwise through the center of the furnace. The trough is filled with coarse graphite particles. This filling not only protects the carborundum trough, but also promotes smooth burning of the arcs by introducing a considerable resistance in series with the arcs and also acts as the heating element when the smothered arc is used. Doors are provided on either end of the furnace through which this trough may be removed and renewed. The filling of the trough can be renewed through these doors and also through the other working doors of the furnace.

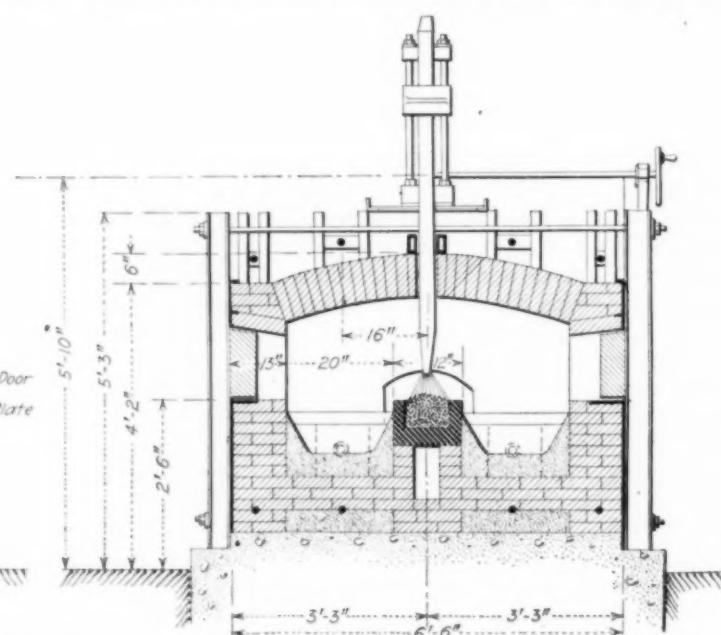
An air duct runs the entire length of the furnace, directly beneath the carborundum trough, providing for the necessary radiation and thus insuring a longer life. The melting chambers are located on both sides and somewhat below the top of the conducting bed. These chambers are lined with either acid or basic materials, as need may require, and the bottoms slope slightly toward the tap holes, located in the front of the furnace.

It will be noted that these melting hearths are independent of each other, in other words, it is possible to charge and tap either one without disturbing the process going on in the other. This arrangement tends to cheapen the labor cost and also to increase the daily output of the furnace.

All doors are of the plug type and as many can be provided as the process would require. This type of door will permit making the furnace as airtight as possible. Ordinarily one door on either side of the furnace should be sufficient unless the furnace is of large size,



RENNERFELT ELECTRIC REVERBERATORY FURNACE



when more doors can easily be built in. In case reduction work is carried out skim plates and skimming doors should be provided for each hearth in the back of the furnace as in ordinary reverberatory furnace construction.

The electric equipment necessary for the furnace is most simple, mainly for the reason that only one voltage of 100-volt low tension will be required, as all heat regulation is obtained by fixing the distance between the conducting bed and the electrodes. No external resistance is necessary. In general, therefore, the electric equipment will consist of oil switch, transformer, instruments and the necessary cables or busbars to bring the current to the electrode contacts. The electrode regulation can be either by hand or automatic.

From this description it can readily be seen that the furnace is adaptable to numerous processes, and also that capacity is unlimited. As all the electrodes are in one row, any multiple can be added, thus giving additional strength to the furnace, and the width of the hearth can also be increased in proportion. When a multiple of electrodes are employed they can be connected up to the same transformer by splitting the phases, but it may be of advantage to employ a number of transformers, each controlling one set of electrodes, independent of the other. By this arrangement it is possible to regulate the heat in the various sections of the furnace.

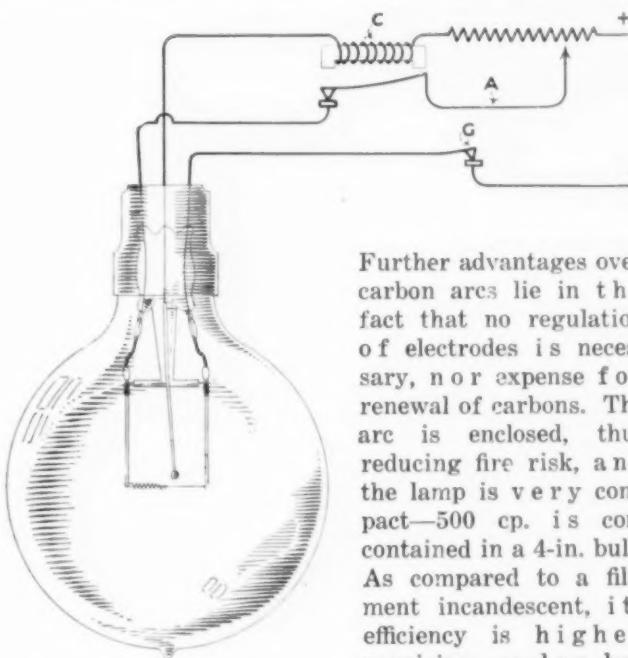
The builder of this furnace, Hamilton & Hansell, Inc., of New York City, has also succeeded in adapting the Rennerfelt Electric Reverberatory to melting glass and enamel by making a slight change in construction and substituting tanks for the melting chamber.

Synopsis of Recent Chemical and Metallurgical Literature

A New Microscope Illuminator.—For the last three years there has been marketed in England under the name "Pointolite" a very interesting lamp, really consisting of a tungsten arc in a gas-filled globe of size of common incandescent bulbs. It was developed by E. A. GIMINGHAM and S. R. MULLARD at the laboratories of the Edison Swan Electric Co., Ltd., Ponders End, Middlesex, and described by them in the *Transactions of the Institution of Electrical Engineers*, vol. 54 (1916), p. 15. With the idea of developing a small, enclosed arc lamp with metallic electrodes, the investigators first built a globule of fused tungsten in actual contact with a brush of tungsten wires, mounting the whole in a nitrogen-filled globe of suitable size. When current was impressed, the heat so warped the supporting wires as to draw the electrodes apart, striking the arc. However, it was found that the metal soon sputtered and stuck together, so that the deformation of the metal supports could not separate the electrodes.

The successful d.c. form is illustrated herewith. To operate, switch *G* is closed, and shunt *A* leading to the filament carries practically all the current. The filament becomes incandescent, ionizing and rendering conductive the gas immediately surrounding it. At first a small current flows through the arc circuit, rapidly increasing until the cut-out is opened, breaking the ionizer circuit and striking the arc. The support is then warped

by heat so that the arc moves slightly along the filament, so that the destructive action of the arc on the ionizing properties of the wire will not prevent re-starting the lamp in its cold position. Practically all the light comes from the 0.1-in. globe of fused tungsten, and does not flicker or wander in the slightest degree.



Further advantages over carbon arcs lie in the fact that no regulation of electrodes is necessary, nor expense for renewal of carbons. The arc is enclosed, thus reducing fire risk, and the lamp is very compact—500 cp. is contained in a 4-in. bulb. As compared to a filament incandescent, its efficiency is higher, requiring under best loading only 0.3 watts per cp., its life is 500 hr., the tungsten ball has 10 times the intrinsic brilliancy of a filament—ranging up to 30,000 cp. per sq.in. The color ranges from yellow to white, depending upon the impressed current, and at heavy duty the spectrum is very continuous and strong, extending about as far into the ultra-violet as the visible range. Under these circumstances, it is readily apparent that the lamp will attract much attention from microscopists needing a continuous concentrated light from a point source.

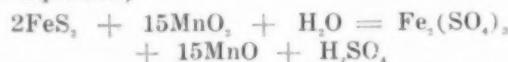
Effect of Copper in Steel.—The Metallurgical and Testing Division, Navy Department, has made experiments on steel in which the copper content was increased to as much as 2 per cent. The gun factory has been manufacturing nickel steel with copper content between 0.4 and 0.7 per cent, and when properly handled these steels showed a marked superiority for most purposes over steel free from copper. Steel containing appreciable amounts of copper when properly made has not been found by them to be more red-short than steel of similar quality free from copper. With poorly made steel red-shortness may be found.

In successfully manufactured steel containing an appreciable amount of copper, precaution must be taken to prevent the copper from liquating or separating during solidification, as the solubility of copper is not as great in ternary alloys as is that of other alloying elements. Usual practice in the gun factory is to keep the manganese content slightly higher when the alloy carries an appreciable amount of copper, which tends to hold the copper without segregation, and prevents the tendency to red-shortness due to the presence of slightly excessive amounts of sulphur.

Steel with 2 per cent copper shows most excellent physical properties when liquation was prevented by rapid solidification of the ingot through a low pouring temperature and by use of a very heavy chill.

Recent Chemical and Metallurgical Patents

Treating Manganese Silver Ores.—LESLIE W. AUSTIN of San José, Cal., finds that it is possible to recover profitably the silver and gold from manganese silver ores by leaching with alkaline sodium cyanide solution if the ore is first treated with sulphuric acid and iron sulphide in the form of pyrite or micasite. The treatment of the ore with sulphuric acid and pyrite reduces the manganese dioxide as indicated in the equation,



In certain cases the ferric sulphate is hydrolyzed, thus,

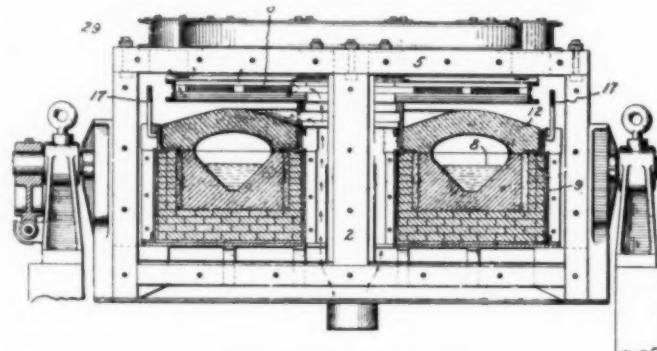


Also there may be formed manganous sulphate. The consumption of sulphuric acid is in most cases small. (1,327,974; Jan. 13, 1920.)

Precipitation of Metals From Solutions.—ARTHUR GORDON of Johannesburg, Transvaal, uses amalgamated aluminum plates for the precipitation of gold or silver from cyanide solutions. The action is more energetic than that of zinc or of a zinc-lead couple, fewer precipitation boxes are needed and it is possible to employ weaker working solutions. A considerable saving is effected thereby. The use of plates $\frac{1}{16}$ in. thick is recommended. These are amalgamated by immersion in a 1 per cent solution of mercuric chloride. The metals are precipitated by the nascent hydrogen which is liberated by the amalgamated plate from the water in the mill solution, and the mercury prevents the formation of a film of oxide on the surface of the plates. In using this method the protective alkalinity of the mill solution is increased to about 0.04 per cent, and lime is preferably used. The lime combines with the liberated hydrocyanic acid and the calcium cyanide so formed is a solvent for gold and silver. (1,328,588; Dec. 2, 1919.)

Induction Furnace.—The design of an induction furnace with the primary winding located entirely above the container for the charge or secondary winding has been suggested. The construction of a commercial furnace of this type has not been attempted, however, because it has been considered necessary to locate the legs of the core outside the essential parts of the magnetic leakage field of the primary winding and the charge. Such a design would necessitate a large core, increasing construction cost, the core loss and the amount of exciting current required. MANGUS UNGER has found that it makes no appreciable difference in the power factor of a furnace to place the legs of the core close to the primary winding and the charge container, and that this construction does not appreciably increase the stray flux loss. The magnetic core of the furnace is so proportioned that the magnetic flux density is substantially uniform when the furnace is under load. This results in a reduction of core loss and the amount of exciting current required in the primary winding. This latter is an important factor in the economy of operation. The details of the design of this furnace are shown in the illustration. The charge to be treated is contained in the annular crucible 8 located beneath the primary winding 6 and

surrounding the central leg 2 of the core. The crucible has a shell 9 provided with insulated joints, is lined with firebrick and is preferably made from magnesite. The crucible cover 12 is supported from the yoke 5 by means of bolts 17, and the yoke, primary windings and crucible cover can be removed as a unit by removing bolts 29. Provision is made to cool the central leg of the core and the primary windings by forced ventilation, as shown by the arrows. The walls of the



INDUCTION FURNACE

crucible are inclined outwardly at an angle of 90 degrees to each other. This construction gives a shallow furnace chamber and permits the bringing of the charge closer to the primary winding than is possible with a deep and narrow chamber. The heating action of the induced current in the charge is greater at the surface, and with this construction the chemical action of the slag is distributed over the maximum amount of highly heated metal. (1,326,120; assigned to the General Electric Co.; Dec. 23, 1919.)

Book Reviews

LECTURE DEMONSTRATIONS IN PHYSICAL CHEMISTRY. By Henry S. Van Kooster, Ph.D., of the department of chemistry, Rensselaer Polytechnic Institute. 196 pp. 83 figs. Easton, Pa.: The Chemical Publishing Co.

One opens a book of the above title with considerable curiosity, for it would seem that the field of physicochemical measurements is a most unpromising one in which to find lecture experiments. A glance at the topics listed under the twelve chapters, however, and a reading of the author's preface, give a new idea of the scope of the book, the purpose of which is to illustrate by qualitative experiments, rather than quantitative measurements, the topics usually considered in physical chemistry. The author evidently considers it a mistake to mingle physicochemical topics with descriptive chemistry, as is done in most text books of general inorganic chemistry.

In all, 253 experiments are listed, under twelve chapters bearing the following titles: General properties of matter in the liquid and solid state; diffusion; osmosis; vapor pressure and determination of molecular weights; chemical equilibrium and the law of mass action; catalysis; electrochemistry and ionic theory; solubility and its changes; colloids and adsorption; actinochemistry; flame, combustion and explosion; liquid air experiments. A bibliography, author index and subject index are included.

The author has brought together a remarkable collection of experiments, gathered from many sources. Numerous references to the original publications enhance the value of the book. It is not quite clear to what extent the author has critically studied the experiments described, and one wishes that the author had injected more of his own experience into the record. As lecture demonstrations a number of the experiments described are on altogether too small a

scale, a fault from which the art of lecture demonstration very frequently suffers. In general, however, the selection of experiments is a happy one, and it must be said that the author has made a valuable contribution in a field to which more attention might well be devoted. No teacher of physical chemistry or of inorganic chemistry can afford to be without this book.

HARRY A. CURTIS.

* * *

JAMES CUTBUSH, AN AMERICAN CHEMIST, 1788-1823. By Edgar F. Smith. 94 pp. Philadelphia, Pa.: J. B. Lippincott Co.

This is another of Provost Smith's delightful biographies of American chemists whose names he rescues from oblivion. It is a little volume that is easily read at a sitting. If anyone should be disposed to complain of what seems almost like unanimity among Dr. Smith's heroes in regard to being born in Philadelphia, he should put an end to his repining, look up the records of his own town, and set forth his findings with similar literary charm—if he has the gift. We are eager to encourage work of this kind, and we shall not press our reservations as to Philadelphia's intellectual leadership in the nation at the time. We admit a strong prepossession in favor of Dr. Smith and his illuminating contributions, but we deny the senatorial incapacity to see merit if it has its origin in other sources.

James Cutbush was the fourth child of a stone-cutter, Edward by given name, and his wife, Anne Marriat. This may indicate a relationship to Captain Marryat, who filled our boyhood hearts with the wish to go to sea and fight battles and see the strange world. He had two brothers, of whom one became prominent as a surgeon in the U. S. Navy, while the other graduated from West Point and attained eminence as an engineer. Where James studied and how is not recorded, but he appears in 1808—at the age of twenty, as the author of some fifteen articles in a Philadelphia newspaper called *Aurora*, in which he explains according to the light of his day many processes of a chemical nature, and urged, as he did throughout his life, the application of the science to industry.

After the death of James Woodhouse, in 1811, when the old Chemical Society of Philadelphia went out of existence, "a number of persons desirous of cultivating chemical science" founded a successor organization, and named it the Columbian Chemical Society. Each year at the fall opening "an oration on some chemical subject" was delivered, and every month "original chemical essays" were presented. We call them all "papers" nowadays, and it might improve the form of some of them if we were to place the responsibility upon the writers of a higher finish, a greater literary polish, in connection with their work. The "Hon. Thomas Jefferson, Esq., was the Patron," and its president was "James Cutbush, Esq., professor of natural philosophy, chemistry and mineralogy in St. John's College." At this time he was twenty-three years old. St. John's College was established and maintained by a Lutheran church of that name in Philadelphia.

Dr. Smith gets a line on Cutbush from a newspaper advertisement of October, 1819, which reads:

Bleaching Liquor, Artificial Musk, Phosphate of Mercury, and Other Chemical Preparations prepared and sold by James Cutbush Chemist and Apothecary No. 25 South Fourth Street, Philadelphia, where complete collections of chemical reagents are kept as usual.

Throughout several years announcements are found by Cutbush in St. John's Lyceum and elsewhere on general chemistry, the theory and practice of pharmacy and other subjects. On Nov. 7, 1811, he delivered an oration before the Society for the Promotion of a Rational System of Education. Dr. Smith says: "His audience was large, and consisted of the very best people of the city. The printed address shows that in addition to his chemical knowledge he was versed in the humanities, in mathematics, in philosophy and ancient history." He urged the introduction of physical science into the curriculum of schools. It hardly seems out of date now, a century later.

Another note that has a modern turn to it is that "He is often referred to as Dr. Cutbush, and in at least two instances the title M.D. is placed after his name. Yet it is a fact that in no place where he is personally responsible for the printing of his name is there any title affixed to it." Apropos of doctorates of courtesy and convention as distinguished from those of academic origin, our readers may recall that in our lament for the passing of William, the dusky servitor of the Chemists' Club, it was observed that as soon as William learned the name of a newly elected member, he addressed him from that time forth as Doctor. These titles were pleasant to the unaccustomed ear, and became known in time as "William's College Degrees." Some of them have remarkable adhesive qualities.

In 1814 James Cutbush was appointed assistant apothecary general to the U. S. Army, although in 1819 he was still in Philadelphia prosecuting his duties. In 1820 he was appointed chief medical officer in the U. S. Military Academy at West Point, where later he became professor of chemistry. Here he addressed himself vigorously to problems of pyrotechnics and explosives. Several pages of questions in regard to pyrotechny are given to indicate his scholarship and methods. His posthumous work on the subject, printed in 1825, has for many years been consulted and referred to by men of science. He was the great pioneer in this field. He must have been a man of mark and attractive personality. Over his grave at West Point is carved this inscription: "Sacred to the Memory of Dr. James Cutbush, Member of the American Philosophical Society, Late Surgeon U. S. Army and Professor of Chemistry, West Point, N. Y., who departed this life Dec. 15, 1823, aged thirty-five years. An honorable tribute of respect from his grateful pupils."

ELLWOOD HENDRICK.

* * *

A HANDBOOK OF BRIQUETTING. VOL. II. By G. Franke. 214 pp., illustrated. Philadelphia, Pa.: J. B. Lippincott Co.

While this book is the second volume of a series published by the author, it is a complete work in itself on the briquetting of ores and metallurgical products. The author is evidently eminently qualified to prepare such a text on this subject, as demonstrated in both this and previous volumes. A reference to and description of plants employing the processes deal mainly with European practice, for the application of briquetting processes to various metallurgical products has progressed far beyond that in American plants.

In addition to briquetting proper, agglomeration or sintering of ores and metallurgical products is also dealt with. This process consists of converting suitable fine material into lumps adapted to the particular smelting operation, without calling in the aid of the processes of molding and compression.

The book opens with a section on the various metallic briquetting materials, with reasons for, and objects of, briquetting them. Briquet testing and characteristics of good briquets, and the composition of various metallurgical and smelting briquets and agglomerates are dealt with. The subject of methods involved in briquetting is thoroughly covered, commencing with the hand-molding of the simple briquet and finishing with fusion processes in electric furnaces, these methods involving the briquetting of materials both with and without binders.

Preparation of the material and subsequent treatment for smelting and fusion embraces a series of chapters which should be of interest to all engineers and operators concerned with metallurgical plants, not only those who are interested in the design of complete new plants, but also where certain additions are contemplated in the existing processes as will effect a saving in the smelting of products which are now considered wastes. The author further enters into descriptions of complete briquetting plants now in operation in European countries. These installations are liberally illustrated by photographs and drawings.

The final pages of the work embrace appendices to both Vols. I and II, which contain further results of tests on pitch and coal briquets, cost of heat, and Hemmerling's

methods for the production of compressed peat blocks; treatment of coal slimes, and briquetting of flue dust.

A careful examination of the text matter shows a large amount of detail on briquetting methods which should be of considerable value to those interested in operating or installing briquetting plants, and the work should command the interest and attention of many who do not now consider themselves concerned with briquetting. American manufacturers are now producing machinery which adequately serves the function of producing briquets under the methods described in this book.

CHESTER H. JONES.

Personal

HARRY E. BISHOP has resigned from the staff of the State Board of Health Laboratories, Indianapolis, Ind., to accept a position in the research laboratory of the National Association of Manufacturers of Glass Containers, Chicago, Ill.

J. S. BROGDON and W. C. DUMAS, formerly state chemist of Georgia, have organized the Brogdon-Dumas Laboratories, Inc., for the conduct of general business as assayers and chemists at Atlanta, Ga.

HERBERT R. HANLEY has returned to San Francisco from a trip to the various Arizona smelters.

Dr. ARTHUR R. HITCH has resigned his position as chief chemist for the Ashland Iron & Mining Co., Ashland, Ky., to accept a position as research chemist with E. I. du Pont de Nemours & Co., at its Jackson Laboratories, Wilmington, Del.

G. W. LAMBOURNE, general manager of the Judge Mining & Smelting Co., has returned to Salt Lake City from a business trip to the Coast.

WILLIAM L. LONG, formerly with Swan-Myers, Indianapolis, Ind., is now chemist with the H. K. Mulford Co., Philadelphia, Pa.

GEORGE D. MC LAUGHLIN has resigned his position as chief chemist of Kullman, Salz & Co., to do research work in colloid chemistry under Dr. Martin H. Fischer, at the University of Cincinnati, Cincinnati, Ohio.

JOHN G. MCLEOD, JR., is now research chemist in the technical service department of the Brompton Pulp & Paper Co., Ltd., East Angus, Que., Canada.

Dr. CHARLES S. PALMER, formerly of the Mellon Institute, Pittsburgh, Pa., has joined the United Fuel Gas Co., Charleston, W. Va., as chief chemist.

B. B. THAYER, vice-president of the Anaconda Copper Mining Co., sailed for Chile on Jan. 31, to inspect the company's properties.

Dr. MAXIMILIAN TOCH of Toch Bros., New York, has been appointed professor of industrial chemistry at Cooper Institute, New York, to lecture on paints, drying oils, resins and rubber.

J. E. TOOMER, formerly research chemist with the Chino Copper Co., Hurley, N. M., has accepted the position of chief chemist with the Morris Fertilizer Co., Atlanta, Ga.

Obituary

PAOLO FISCHER, at one time an assistant to Stassano, the Italian builder of electric furnaces, died recently in Chicago. Mr. Fischer was widely known in Europe in connection with the early development of the electric furnace. He designed the plant which was operated for some time at Buchanan, Mich., and more recently had designed a proposed plant for installation near the Keokuk dam.

C. H. INGRAM, of the Ruhm Phosphate Mining Co., died Jan. 8 at Mt. Pleasant, Tenn., after a short illness from pneumonia. Mr. Ingram had been actively connected with the phosphate business since its discovery in Tennessee and was widely known and very popular in the trade.

Current Market Reports

The Non-Ferrous Metal Market

New York, Feb. 9, 1920.—Little movement in the market. Nickel remained stationary; copper, zinc, tin and silver declined slightly; lead advanced from 8.62½c. to 8.80c., New York.

	Cents per Lb.
Copper, electrolytic	18.50
Aluminum, 98 to 99 per cent	31½@32½
Antimony, wholesale lots	11.50
Nickel, ordinary	43.00
Nickel, electrolytic	45.00
Tin, Straits spot	57.50
Lead, New York, spot	8.80
Lead, E. St. Louis, spot	8.45
Zinc, spot, New York	9.05
Zinc, spot, E. St. Louis	8.70
Silver	1.32½
	(Dollars per oz.)

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	27.50
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	33.50
Seamless bronze tubing	34.50
Seamless brass tubing	30.50

RARER METALS

	Ib. \$1.50
Cadmium	1 lb. 1.50
Cobalt	ox. 150.00
Platinum	oz. 250.00
Iridium	oz. 150.00
Palladium	75 lb. 80.00
Mercury	

SCRAP METALS

	Cents per Lb.
Aluminum, cast scrap	23½@24½
Aluminum, sheet scrap	22½@23½
Aluminum clippings	25½@27
Copper, heavy machinery comp.	14½@14
Copper, heavy and wire	13½@14
Copper, light and bottoms	12½@12
Copper, heavy cut and crucible	15½@16
Brass, heavy	7½@8½
Brass, casting	10½@10
Brass, light	5½@6½
No. 1 clean brass turnings	8½@8½
No. 1 comp. turnings	12½@12½
Lead, tea	5½@5½
Lead, heavy	6½@7
Zinc, scrap	4½@4½

The Iron and Steel Market

Pittsburgh, February 6, 1920.

The runaway steel market, referred to in last report as having in all probability developed, is clearly defined as such. The market is nothing if not a runaway. There are no regular market prices. The Steel Corporation subsidiaries have a very well defined schedule of prices, the March 21, 1919, or "Industrial Board" schedule, but only its regular customers can buy at those prices, and then in many cases not as large tonnages as they desire. Among the independents there is probably not one that is willing to sell anyone at the March 21 schedule, while furthermore the prices quoted by independents, when they quote at all, very seldom agree. Competition does not force the market of the independents to a definite level, for the reason that the individual producers do not offer as much steel as buyers desire to purchase.

While technically there is a clearly defined condition of a runaway market, it cannot be observed that the market is running away very fast. Whether this feature is due to reserve on the part of sellers or reserve on the part of buyers cannot be determined at this time. No canvass of buyers can be made which would show the distance ahead to which they are willing to commit themselves at one price or another if given the opportunity.

One large independent steel interest is engaged in its own effort to stabilize the market, but apparently has no company. Its prices for a variety of steel products, with perhaps an occasional exception, are what are known as "Jan. 1" prices, the prices from which the Industrial Board reductions were made March 21, and to which prices were

reduced shortly after the armistice. The Jan. 1 prices are, for illustration, 2.70c., 2.80c. and 3c. for bars, shapes and plates respectively.

OPERATIONS

Steel production in January was not far from 85 per cent of capacity, and while the tonnage proved larger than had been predicted, the producers profess themselves much disappointed at conditions today, there having been little if any further increase in the production rate since the middle of January. With scarcely an exception producers ascribe the restriction to a shortage in transportation, which touches the industry in various ways—in preventing an increase in production and shipment of Connellsville coke, in limiting the shipment of coal for steel mill and byproduct oven use and in preventing all steel made from being shipped. At some mills there are large accumulations of finished product threatening to back up against the rolls and force stoppages. The railroads are not disorganized, but they have not the reserve force to cope with existing conditions, particularly the winter weather. Given a continued summer they might do fairly well.

The automobile industry is having an influence upon the steel market that is greatly regretted by many other classes of consumers, as the automobile factories are so situated that it is a matter of indifference to them what prices they pay for such small lots of steel, relative to their regular supplies, as they need in order to maintain operations. Some steel buyers feel strongly that the automobile industry is making an impress upon the steel market out of proportion to the tonnage importance of the additional steel it now requires, for all or nearly all the established factories have large tonnages of steel reaching them from week to week on old contracts, at prices much below those now bid for small prompt lots.

LAKE SUPERIOR IRON ORE MARKET OPENS

The Lake Superior iron ore market for the 1920 season was opened in Cleveland Monday, Feb. 2, by representative sales, and in accordance with a habit formed long ago the producers will adhere during the season to the prices thus developed. There is a uniform advance on the four groups of ores of \$1 per ton over the 1919 schedule, making prices as follows at Lake Erie docks: old range bessemer, \$7.45; old range non-bessemer, \$6.70; Mesabi bessemer, \$7.20; Mesabi non-bessemer, \$6.55. These prices are the highest in a statistical record which begins with 1894 in the case of Mesabi ores and with 1885 in the case of old range ores. The advance, however, is moderate relative to the prevailing prices of pig iron. Mesabi non-bessemer, for instance, is at the new rate 95 per cent above its 10-yr. pre-war average in the seasons of 1904 to 1913 inclusive, while pig iron is fully 150 per cent above its corresponding pre-war average.

PIG IRON

The pig iron market is in stronger position, although no additional advances are to be recorded for the past week. Foundry iron is \$40, Birmingham, and foundry and basic \$40, valley, with bessemer at \$41. These quotations are based on last important sales, but it is doubtful whether much additional tonnage can be had at the prices, while buyers are taking hold somewhat more freely than formerly.

UNFINISHED STEEL

No definite prices can be quoted for unfinished steel, each of the few transactions made being a law to itself. In the past week a sale of sheet bars has been made at \$65 and another at \$56, the circumstances not being greatly different as to tonnage and delivery. Small billets have sold at \$60.

The Ferro-Alloy Market

New York, February 7, 1920.

The car shortage is hitting the manufacturers not only in the scarcity of incoming raw material but also in the outgoing product. Deliveries on contracts are being delayed and producers are taxing their resources to keep the mills supplied.

Ferromanganese continues the most important item of the alloys; difficulty is experienced in obtaining it at \$160 per ton. Spiegeleisen is strong under the impetus of the manganese demand, and the average price quoted is around \$55 per ton. There has been some small business in ferro-chrome at 25c. per lb., but buyers are few and far between.

The coke situation remains unchanged, indifference on the part of labor to the necessity of increasing production, extreme car shortage (totaling 30 to 35 per cent of normal number of cars), and the cold weather have successfully combined to practically cripple this industry.

The Chemical Market

New York, February 7, 1920.

The chemical market during the past week continued evenly balanced, with a slight drop in activity probably due to a scarcity of spot material. Prices have not been affected by this scarcity and remain at practically the same level as the previous report.

Aqua ammonia remains firm at 8 $\frac{3}{4}$ @10 $\frac{1}{4}$ c. due principally to the lack of supplies caused by the recent coal shortage. This item has not recovered, and with the present demand prices will continue at the present level. Manufacturers are offering *white sal ammoniac*, granular, at 12 $\frac{3}{4}$ @14c. per lb. and the gray at 12@12 $\frac{1}{4}$ c. Spot materials are scarce, but contracts for forward delivery are being taken. *Bleaching powder* is practically off the spot market at present. Manufacturers who are fairly well sold up on this item are quoting \$2.50@\$3 per cwt. *Glauber's salts* has been quiet. Buyers have been taking a routine supply, but with the present stocks no immediate rise is looked for.

Potassium carbonate is difficult to locate on spot, but there has been some trading at 24@27c. per lb., mostly on contract, as the entire supply is in the hands of a few. *Potassium hydroxide* remains firm at 23@32c. per lb. There has been some business in spot goods in a small way at 30c. per lb. *Oxalic* has had another jump and is now quoted at 35@40c. per lb. Import grades from England are to be had at 38c. but domestic producers with their rather scanty stock are holding firm at 40c.

COAL-TAR PRODUCTS

This branch of the market has been quiet during the past week, due principally to uncertainty as to the tariff, which is at present under discussion in Washington. Opinion is divided regarding what action Congress should take, the producer of coal-tar intermediates and dyestuffs holding that a restrictive tariff should be placed on all imported goods sufficient to protect the domestic manufacturer, while the textile and mill people, who desire to obtain these items at the lowest possible figure, claim this would do away with competition. Definite action will certainly ease the market. *Cresyllic acid*, 97-99 per cent, has advanced from 75@80c. per gal. of last week to 90c.@\$1.10, while 95-97 per cent also came up to 80c@\$1, with supply falling off, and further advances are looked for soon. *Phthalic anhydride* remains at 60c. per lb. There are plentiful stocks of this material in the hands of large producers. Through a typographical error the prices on *salicylic acid* were reversed. The present quotation is 43@45c. per lb. for tech. and 55@60c. for U. S. P. grade. *Benzol* has been easier due to a replenished stock. This item can be obtained by actual users in reasonable quantities for prompt shipment at 27c. per gal. *Phenol* remains unchanged and the large stocks on this item have kept the price at 12c. per lb.

NAVAL STORES

Turpentine continues upward, the present quotation in the local market being \$2.04 per gal., while *Savannah* is quoted at \$1.97 per gal. *Rosins* remain firm with a slight falling off in inquiry.

CRUDE RUBBER

The crude rubber market continues easy, buyers holding out for more favorable prices. Manufacturers are fairly well supplied and are not in the market except for concessions, and the present indication is that a still further drop will take place.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots	Carlots	Less Carlots
Acetic anhydride.	lb. \$0.16 - \$0.20	\$0.60 - \$0.65	Potassium prussiate, yellow.	ton \$225.00
Acetone.	cwt. 2.50 - 3.00	3.00 - 3.25	Potassium sulphate.	ton \$225.00
Acid, acetic, 28 per cent.	cwt. 5.00 - 5.50	6.00 - 6.50	Rochelle salt (see sodium potash tartrate).	-
Acetic, 56 per cent.	cwt. 12.00 - 12.50	13.50 - 15.50	Sal ammoniac (see ammonium chloride).	-
Acetic, glacial, 99 per cent, carboys.	cwt. 14.40 - 15.50	15.50 - 16.50	Sal soda (see sodium carbonate).	-
Boric, crystals.	lb. 14.40 - 15	15 - 16	Salt cake (sodium sulphate).	ton 18.00 - 21.00
Boric, powder.	lb. 08 -	.09 - .10	Silver cyanide.	oz. 1.25 -
Hydrochloric.	lb. 12 -	.14 -	Silver nitrate.	oz. .81 - .82
Hydrofluoric, 52 per cent.	lb. 11 - 11.50	12 - 16	Soda ash, light.	100 lb. 2.05 -
Lactic, 44 per cent tech.	lb. 11 - 11.50	12 - 16	Soda ash, dense.	100 lb. 2.25 - 2.35
Lactic, 22 per cent tech.	lb. 05 - .06	.054 - .07	Sodium acetate.	lb. .064 - .07
Molybdic, C. P.	lb. -	4.25 - 5.00	Sodium bicarbonate.	100 lb. 2.40 -
Nitric, 40 deg.	lb. 06 - .064	.07 - .084	Sodium bichromate.	lb. .20 - .21
Nitric, 42 deg.	lb. 064 - .07	.08 - .094	Sodium bisulphite (nitre cake).	cwt. 5.00 - 6.00
Oxalic, crystals.	lb. 35 - 40	.40 - .45	Sodium borate (borax).	ton 7.00 - 8.00
Phosphoric, Ortho, 50 per cent solution.	lb. 24 -	-	Sodium carbonate (sal soda).	100 lb. 1.40 - 1.55
Picric.	lb. 30 - 35	.40 - .50	Sodium chlorate.	lb. .10 -
Pyrogalllic, resublimed.	lb. 2.20 - 2.40	2.30 - 2.60	Sodium cyanide, 96-98 per cent.	lb. .30 -
Sulphuric, 60 deg., tank cars.	ton 17.50 - 22.00	-	Sodium fluoride.	lb. .14 -
Sulphuric, 60 deg., drums.	ton 22.00 - 25.00	-	Sodium hydroxide (caustic soda).	100 lb. -
Sulphuric, 66 deg., tank cars.	ton -	-	Sodium hyposulphite.	lb. -
Sulphuric, 66 deg., drums.	ton -	-	Sodium molybdate.	100 lb. 3.00 - 3.25
Sulphuric, 68 deg., carboys.	ton -	-	Sodium nitrate.	100 lb. 3.75 - 4.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.	ton 30.00 -	32.00 -	Sodium nitrite.	lb. 15 - 17
Sulphuric, fuming, 20 per cent (oleum) drums.	ton 32.00 -	34.00 -	Sodium peroxide, powdered.	lb. -
Sulphuric, fuming, 20 per cent (oleum) carboys.	ton 35.00 -	40.00 -	Sodium phosphate, dibasic.	lb. .034 - .044
Tannic, U. S. P.	lb. -	1.35 - 1.45	Sodium potassium tartrate (Rochelle salt).	lb. .40 - .42
Tannic (tech.).	lb. -	.42 - .55	Sodium prussiate, yellow.	lb. .23 - .39
Tartaric, crystals.	lb. -	.69 - .74	Sodium silicate, solution (40 deg.).	lb. .01 - .02
Tungstic, per lb. of WO ₃ .	lb. -	1.20 - 1.40	Sodium silicate, solution (60 deg.).	lb. .02 - .03
*Alcohol, Ethyl.	gal. 4.80 - 5.50	6.00 - 7.00	Sodium sulphate, crystals (Glauber's salts) cwt.	1.30 - 1.50
*Alcohol, Methyl.	gal. 1.50 -	1.52 - 1.57	Sodium sulphide, crystal, 60-62 per cent (cone).	lb. -
*Alcohol, denatured, 188 proof.	gal. -	.76 - .78	Sodium sulphite, crystals.	lb. .034 - .04
*Alcohol, denatured, 190 proof.	gal. -	.71 - .73	Strontium nitrate, crystals.	lb. .25 -
Alum, ammonia lump.	lb. .044 - .05	.044 - .044	Sulphur chloride.	lb. .054 -
Alum, potash lump.	lb. .08 - .084	.09 - .094	Sulphur, crude.	ton 22.00 -
Alum, chrome lump.	lb. 15 - 16	.18 - .20	Sulphur dioxide, liquid, cylinders.	lb. .09 -
Aluminum sulphate, commercial.	lb. .014 - .02	.024 - .024	Sulphur (sublimed), flour.	100 lb. 3.35 -
Aluminum sulphate, iron free.	lb. .024 - .03	.034 - .034	Sulphur, roll (brimstone).	100 lb. 3.20 -
Aqua ammonia, 26 deg., drums (750 lb.).	lb. .084 - .104	.11 - .12	Tin bichloride (stannous).	lb. .424 -
Ammonia, anhydrous, cylinders (100-150 lb.)	lb. -	.30 - .35	Tin oxide.	lb. .50 - .60
Ammonium carbonate, powder.	lb. -	.13 - .164	Zinc carbonate, precipitate.	lb. -
Ammonium chloride, granular (white sal ammoniac).	lb. -	.124 - .14	Zinc chloride, gran.	lb. .13 -
Ammonium chloride, granular (gray sal ammoniac).	lb. -	.12 - .124	Zinc cyanide.	lb. .49 -
Ammonium nitrate.	lb. -	.22 -	Zinc dust.	lb. .114 - .124
Ammonium sulphate.	lb. .05 -	.06 -	Zinc oxide, dry American.	lb. .094 - .12
Amylacetate.	gal. -	3.65 - 3.75	Zinc sulphate.	lb. .034 - .034
Arsenic, oxide, lumps (white arsenic).	lb. 23 - 24	.104 - .11		
Arsenic, sulphide, powdered (red arsenic).	ton 80.00 - 85.00	100.00 - 110.00		
Barium chloride.	lb. 22 -	.24 -		
Barium oxide (peroxide).	lb. 11 - 13	.11 - .12		
Barium nitrate.	lb. .03 - .034	.034 - .04		
Barium sulphate (precip.) (blanc fixe).	lb. -	-		
Bleaching powder (see calcium hypochlorite).	ton -	-		
Blue vitriol (see copper sulphate).	ton -	-		
Borax (see sodium borate).	ton -	-		
Brimstone (see sulphur, roll).	ton -	-		
Bromine.	lb. .90 - .95	-		
Calcium acetate.	cwt. 2.00 - 2.05	2.10 -		
Calcium carbide.	lb. -	.044 - .05		
Calcium chloride, fused, lump.	ton 20.00 - 25.00	30.00 - 40.00		
Calcium chloride, granulated.	lb. .014 - .014	.02 - .024		
Calcium hypochlorite (bleaching powder).	cwt. -	2.50 - 3.00		
Calcium peroxide.	lb. -	1.50 - 1.70		
Calcium phosphate, monobasic.	lb. -	.75 - .80		
Calcium sulphate, pure.	lb. -	.25 - .30		
Carbon bisulphide.	lb. .06 - .08	.09 - .10		
Carbon tetrachloride, drums.	lb. -	.11 - .12		
Carbonyl chloride (phosgene).	lb. -	.75 -		
Caustic potash (see potassium hydroxide).	ton -	-		
Caustic soda (see sodium hydroxide).	ton -	-		
Chlorine, gas, liquid-cylinders (100 lb.).	lb. .05 - .054	.08 -		
Chloroform.	lb. .28 - .29	.30 - .31		
Cobalt oxide.	lb. -	1.50 - 1.55		
Copperas (see iron sulphate).	lb. -	-		
Copper carbonate, green precipitate.	lb. -	.28 - .31		
Copper cyanide.	lb. -	.65 - .70		
Copper sulphate, crystals.	lb. .074 - .084	.09 - .094		
Cream of tartar (see potassium bitartrate).	ton -	-		
Epsom salt (see magnesium sulphate).	ton -	-		
Formaldehyde, 40 per cent.	lb. -	.51 - .52		
Glauber's salt (see sodium sulphate).	ton -	-		
Glycerine.	lb. -	.244 - .26		
Iodine, resublimed.	lb. -	4.10 - 4.30		
Iron oxide, red.	lb. -	.03 - .20		
Iron sulphate (copperas).	cwt. 1.20 -	1.25 - 1.75		
Lead acetate, normal.	lb. -	.14 - .23		
Lead arsenate (paste).	lb. -	.13 - .17		
Lead nitrate, crystals.	lb. -	.70 - .80		
Litharge.	lb. -	.094 - .104		
Lithium carbonate.	lb. -	1.50 -		
Magnesium carbonate, technical.	lb. -	.13 - .144		
Magnesium sulphate, U. S. P.	100 lb. 2.15 - 2.63	2.75 - 3.00		
Magnesium sulphate, commercial.	100 lb. -	2.00 - 2.50		
Nickel salt, double.	lb. 1.4 -	.15 -		
Nickel salt, single.	lb. 1.6 -	.17 -		
Phosphate (see carbonyl chloride).	ton -	-		
Phosphorus, red.	lb. -	.60 - .90		
Phosphorus, yellow.	lb. -	.35 - .37		
Potassium bichromate.	lb. 28 - .33	.34 - .35		
Potassium bitartrate (cream of Tartar).	lb. -	.56 - .60		
Potassium bromide, granular.	lb. -	.50 - .65		
Potassium carbonate, U. S. P.	lb. 26 - .27	.28 - .30		
Potassium carbonate, crude.	lb. 16 - .20	.21 -		
Potassium chlorate, crystals.	nominal -	-		
Potassium cyanide, 98-99 per cent.	lb. .23 - .32	.35 - .42		
Potassium hydroxide (caustic potash).	lb. -	3.35 - 3.60		
Potassium iodide.	lb. -	.21 -		
Potassium nitrate.	lb. 19 -	-		
Potassium permanganate.	lb. -	.65 - .75		
Potassium prussiate, red.	lb. -	1.10 - 1.20		

*Nominal quotations.

	Carlots	Less Carlots	Carlots	Less Carlots
Potassium prussiate, yellow.	ton \$225.00	-	ton \$20.40 - \$20.70	-
Potassium sulphate.	-	-	-	-
Rochelle salt (see sodium potash tartrate).	-	-	-	-
Sal ammoniac (see ammonium chloride).	-	-	-	-
Sal soda (see sodium carbonate).	-	-	-	-
Salt cake (sodium sulphate).	ton 18.00	- 21.00	-	-
Silver cyanide.	oz. -	-	1.25 -	
Silver nitrate.	oz. -	-	.81 - .82	
Soda ash, light.	100 lb. 2.05 -	2.25 -		
Soda ash, dense.	100 lb. 2.25 - 2.35	2.50 - 2.75		
Sodium acetate.	lb. .064 - .07	.07 - .08		
Sodium bicarbonate.	100 lb. 2.40 -	2.75 - 3.00		
Sodium bichromate.	lb. .20 - .21	.22 - .25		
Sodium bisulphite (nitre cake).	cwt. 5.00 - 6.00	8.00 - 10.00		
Sodium bisulphite.	ton 7.00 - 8.00	8.50 - 9.00		
Sodium borate (borax).	lb. .084 - .084	.09 - .09		
Sodium carbonate (sal soda).	100 lb. 1.40 - 1.55	1.50 - 1.75		
Sodium chlorate.	lb. .10 -	.12 - .14		
Sodium cyanide, 96-98 per cent.	lb. .30 -	.31 - .34		
Sodium fluoride.	lb. .14 -	.15 - .16		
Sodium hydroxide (caustic soda).	100 lb. -	4.35 - 4.50		
Sodium hyposulphite.	lb. -	.034 - .04		
Sodium molybdate.	100 lb. 3.00 - 3.25	3.75 - 4.00		
Sodium nitrate.	100 lb. 3.75 - 4.00	4.00 - 4.20		
Sodium nitrite.	lb. 15 - 17	.18 - .20		
Sodium peroxide, powdered.	lb. -	.30 - .32		
Sodium phosphate, dibasic.	lb. .034 - .044	.044 - .05		
Sodium potassium tartrate (Rochelle salt).	lb. .40 - .42	.43 - .45		
Sodium prussiate, yellow.	lb. .23 - .39	.24 - .40		
Sodium silicate, solution (40 deg.).	lb. .01 - .02	.02 - .024		
Sodium silicate, solution (60 deg.).	lb. .024 - .03	.05 - .06		
Sodium sulphate, crystals (Glauber's salts) cwt.	1.30 - 1.50	1.60 - 2.00		
Sodium sulphide, crystal, 60-62 per cent (cone).	lb. -	.05 - .06		
Sodium sulphite, crystals.	lb. .034 - .04	.04 - .06		
Strontium nitrate, crystals.	lb. .25 -	.28 -		
Sulphur chloride.	lb. .054 -	.06 -		
Sulphur, crude.	ton 22.00 -	-		
Sulphur dioxide, liquid, cylinders.	lb. .09 -	.10 - .12		
Sulphur (sublimed), flour.	100 lb. 3.35 -	3.40 - 3.65		
Sulphur, roll (brimstone).	100 lb. 3.20 -	3.30 - 3.40		
Tin bichloride (stannous).	lb. .424 -	.46 - .50		
Tin oxide.	lb. .50 - .60	.65 -		
Zinc carbonate, precipitate.	lb. -	.20 -		
Zinc chloride, gran.	lb. .13 -	.134 - .15		
Zinc cyanide.	lb. .49 -	.50 -		
Zinc dust.	lb. .114 - .124	.13 - .15		
Zinc oxide, dry American.	lb. .094 - .12	.094 - .12		
Zinc sulphate.	lb. .034 - .034	.04 - .044		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:				
Alpha naphthal, crude.	lb. \$1.00	—	\$1.10	
Alpha naphthal, refined.	lb. 1.40	—	1.60	
Alpha naphthylamine.	lb. .34	—	.36	
Aniline oil, drume extra.	lb. .34	—	.36	
Aniline salts.	lb. .42	—	.50	
Anthracene, 80% in drums (100 lb.).	lb. .75	—	1.00	
Benzaldehyde (f.c.).	lb. 2.00	—	2.10	
Benzidine, base.	lb. 1.25	—	1.30	
Benzidine, sulphate.	lb. .90	—	1.00	
Benzoin, U.S.P.	lb. .80	—	1.00	
Benzosote of soda, U.S.P.	gal. .27	—	.36	
Benzol, pure, water-white, in drums (100 lb.).	gal. .25	—	.29	
Benzol, 90%, in drums (100 lb.).	gal. .35	—	.40	
Benzyl chloride, 95-97%, refined.	lb. .25	—	.35	
Benzyl chloride, tech.	lb. .50	—	.52	
Beta naphthal, benzoate.	lb. .65	—	.80	
Beta naphthal, sublimed.	lb. .45	—	.55	
Beta naphthylamine, sublimed.	lb. 2.25	—	2.35	
Cresol, U.S.P., in drums (100 lb.).	lb. .16	—	.18	
Ortho-cresol, in drums (100 lb.).	lb. .23	—	.25	
Cresylic acid, 97-99%, straw color, in drums.	gal. .90	—	1.10	
Cresylic acid, 50%, first quality, drums.	gal. .80	—	1.00	
Dichlorbenzol.	lb. .07	—	.10	
Diethylaniline.	lb. .90	—	1.00	
Dimethylaniline.	lb. .26	—	.37	
Dinitrobenzol.	lb. .25	—	.30	
Dinitrochlorbenzol.	lb. .45	—	.55	

Toluidine.....	lb.	\$1.70	—	\$2.50
Toluidine, mixed.....	lb.	.45	—	.55
Toluol, in tank cars.....	gal.	.28	—	...
Toluol, in drums.....	gal.	.29	—	.32
Xylidine, drums, 100 gal.....	lb.	.44	—	.50
Xylool, pure, in drums.....	gal.	.37	—	.45
Xylool, pure, in tank cars.....	gal.	.35	—	...
Xylool, commercial, in drums, 100 gal.....	gal.	.37	—	.45
Xylool, commercial, in tank cars.....	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, natural crude, yellow.....	lb.	\$0.42	—	\$0.45
Beeswax, refined, yellow.....	lb.	.47	—	.48
Beeswax, white, pure.....	lb.	.63	—	.68
Carnauba, No. 1.....	lb.	.80	—	.88
Carnauba, No. 2, regular.....	lb.	.65	—	.78
Carnauba, No. 3, North Country.....	lb.	.46	—	.48
Japan.....	lb.	.18	—	.20
Paraffine waxes, crude match wax(white) 105-110 m.p.....	lb.	.06	—	.07
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	—	—	.07
Paraffine waxes, refined, 118-120 m.p.....	lb.	—	—	.10
Paraffine waxes, refined, 128-130 m.p.....	lb.	.09	—	.10
Paraffine waxes, refined, 133-135 m.p.....	lb.	—	—	.13
Paraffine waxes, refined, 135-137 m.p.....	lb.	—	—	.14
Stearic acid, single pressed.....	lb.	.23	—	.26
Stearic acid, double pressed.....	lb.	.28	—	.29
Stearic acid, triple pressed.....	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1.45
Pine oil, pure, dest. dist.....	gal.	—
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.40
Pine taroil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. gal.	gal.	.48
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.70
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.38
Turpentine, crude, sp.gr. 0.900-0.970.....	gal.	1.60
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.35
Pinewood creosote, ref.....	gal.	.52

Naval Stores

The following prices are f.o.b., New York, for carload lots:

Rosin B-D, bbl.....	280 lb.	\$19.00	—	\$19.50
Rosin E-I.....	280 lb.	19.50	—	19.70
Rosin K-N.....	280 lb.	19.75	—	22.50
Rosin W. G.-W. W.....	280 lb.	22.50	—	24.25
Wood rosin, bbl.....	280 lb.	17.00	—	17.50
Spirits of turpentine.....	gal.	—	—	2.04
Wood turpentine, steam dist.....	gal.	—	—	1.70
Wood turpentine, dest. dist.....	gal.	1.64	—	—
Pine tar pitch, bbl.....	200 lb.	8.25	—	8.50
Tar, kiln burned, bbl. (500 lb.).....	bbl.	14.50	—	14.75
Retort tar, bbl. (500 lb.).....	bbl.	15.00	—	15.25
Rosin oil, first run.....	gal.	—	—	.91
Rosin oil, second run.....	gal.	.93	—	.94
Rosin oil, third run.....	gal.	1.10	—	1.12
Rosin oil, fourth run.....	gal.	—	—	1.15

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.33
70-72 deg., steel bbls. (85 lb.).....	gal.	.31
68-70 deg., steel bbls. (85 lb.).....	gal.	.30
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.23

Crude Rubber

Para—Upriver fine.....	lb.	\$0.44	—	\$0.46
Upriver coarse.....	lb.	.33	—	.35
Upriver caucho ball.....	lb.	.33	—	.34
Plantation—First latex crepe.....	lb.	.50	—	.54
Ribbed smoked sheets.....	lb.	.49	—	.51
Brown crepe, thin, clean.....	lb.	.48	—	.48
Amber crepe No. 1.....	lb.	.53	—	—

Oils**VEGETABLE**

The following prices are f.o.b., New York, for carload lots:				
Castor oil, No. 3, in bbls.....	lb.	\$0.18	—	\$0.19
Castor oil, AA, in bbls.....	lb.	.21	—	.23
China wood oil, in bbls.....	lb.	.23	—	.24
Cocoanut oil, Ceylon grade, in bbls.....	lb.	.21	—	.21
Cocoanut oil, Cochin grade, in bbls.....	lb.	.20	—	.23
Corn oil, crude, in bbls.....	lb.	.19	—	.22
Cottonseed oil, crude (f.o.b. mill).....	lb.	.19	—	.20
Cottonseed oil, summer yellow.....	lb.	.22	—	.27
Cottonseed oil, winter yellow.....	lb.	.24	—	.25
Linseed oil, raw, car lots.....	gal.	1.77	—	1.87
Linseed oil, raw, tank cars.....	gal.	1.70	—	1.80
Linseed oil, boiled, car lots.....	gal.	1.75	—	1.80
Olive oil, commercial.....	gal.	2.50	—	2.60
Palm, Lagos.....	lb.	.17	—	.18
Palm, bright red.....	lb.	.16	—	.17
Palm, Niger.....	lb.	.16	—	.17
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.23	—	.24
Peanut oil, refined, in bbls.....	lb.	.27	—	.28
Rapeseed oil, refined in bbls.....	gal.	1.45	—	1.68
Rapeseed oil, blown, in bbls.....	gal.	1.60	—	1.70
Soya bean oil (Manchurian), in bbls. N.Y.....	lb.	.19	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.17	—	.20

FISH

Winter pressed Menhaden.....	gal.	\$1.20	—	—
Yellow bleached Menhaden.....	gal.	1.23	—	—
White bleached Menhaden.....	gal.	1.25	—	—
Blown Menhaden.....	gal.	1.26	—	—

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated.....	ton	\$35.00	—	\$40.00
Barytes, off color.....	ton	20.00	—	25.00
Blanc fixe, dry.....	lb.	.03	—	.04
Blanc fixe, pulp.....	ton	30.00	—	50.00
Casein.....	lb.	.16	—	.18
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.04	—	.05
China clay (Kaolin), imported, lump.....	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	ton	30.00	—	60.00
Feldspar.....	ton	25.00	—	40.00
Fluorspar, acid grade, lump, f.o.b. mines.....	ton	13.50	—	18.00
Fluorspar, acid grade, ground, f.o.b. mines.....	net ton	40.00	—	45.00
Fuller's earth, domestic, powdered.....	ton	50.00	—	52.00
Fuller's earth, imported, powdered.....	ton	35.00	—	40.00
Graphite, crucible, 85% Carbon content.....	lb.	—	—	.07
Graphite, crucible, 86% Carbon content.....	lb.	—	—	.07
Graphite, crucible, 87% Carbon content.....	lb.	—	—	.08
Graphite, crucible, 88% Carbon content.....	lb.	—	—	.08
Graphite, crucible, 89% Carbon content.....	lb.	—	—	.08
Graphite, crucible, 90% Carbon content.....	lb.	—	—	.08
Graphite, crucible, 91% Carbon content.....	lb.	—	—	.08
Graphite, crucible, 92% Carbon content.....	lb.	—	—	.09
Pumice stone, imported.....	lb.	.03	—	.06
Pumice stone, domestic.....	lb.	.02	—	—
Shellac, TN.....	lb.	1.10	—	1.15
Shellac, D. C.	lb.	—	—	—
Shellac, V. S. O.	lb.	—	—	—
Shellac, Diamond I.	lb.	—	—	—
Shellac, orange, fine.....	lb.	1.25	—	—
Shellac, orange, superfine.....	lb.	1.20	—	1.30
Shellac, A. C. garnet.....	lb.	1.35	—	—
Shellac, bleached, bone dry.....	lb.	1.10	—	1.15
Shellac, bleached, fresh ground.....	lb.	1.10	—	—
Soapstone.....	ton	15.00	—	25.00
Talc, domestic.....	ton	16.00	—	60.00
Talc, imported.....	ton	60.00	—	70.00

Refractories

Following prices are f.o.b. works:

Chrome brick.....	net ton	—	—	—
Chrome cement.....	net ton	—	—	—
Clay brick, 1st quality fireclay.....	1,000	—	—	—
Clay brick, 2nd quality.....	1,000	—	—	—
Magnesite, dead burned.....	net ton	—	—	—
Magnesite brick, 9 x 4 x 2 1/2 in.	net ton	—	—	—
Silica brick.....	1,000	—	—	—

375-80 at Chester, Penn.

45-50 at Chester, Penn.

38-45 at Clearfield, Penn.

33-35 at Clearfield, Penn.

50-55 at Chester, Penn.

80-85 at Chester, Penn.

45-50 at Mt. Union, Penn.

Ferro-Alloys

All prices f.o.b. works.

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	\$200.00	—	\$250.00
Ferro-chrome per lb. of Cr contained, 6-8% carbon.....	lb.	.20	—	.40
Ferro-chrome per lb. of Cr contained, 2-4% carbon.....	lb.	.21	—	.50
Ferro-manganese, 70-80% Mn.....	gross ton	150.00	—	160.00
Spiegeleisen, 16-20% Mn.....	gross ton	40.00	—	50.00
Ferro-molybdenum, per lb. of Mo.....	lb.	3.00	—	3.50
Ferro-silicon, 50%.....	gross ton	85.00	—	95.00
Ferro-silicon, 75%.....	gross ton	150.00	—	175.00
Ferro-silicon, 10-15%.....	gross ton	45.00	—	60.00
Ferro-tungsten, 70-80%, per lb. of contained W.....	lb.	1.25	—	1.40
Ferro-uranium, 35-50%, per lb. of U.....	lb.	7.00	—	—
Ferro-vanadium, 30-40% per lb. of contained V.....	lb.	5.50	—	7.00

* Government prices.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

NEW HAVEN—The State Bd. of Health, 308 Church St., Hartford, and Bilderbeck & Langdin, archts., Manwaring Bldg., New London, will receive bids about March 1 for the construction of a 3-story, 51 x 111 ft. laboratory and experimental station on Highland St. Testing and experimental apparatus will be installed in same. Total estimated cost, \$125,000.

Illinois

CHICAGO—The Illinois Glass Co. is having plans prepared for the construction of an addition to the plant which will be built at Crawford and Whitewood Aves. Estimated cost, \$250,000. The company also plans to build addition to the plants of the United States Bottlers' Machinery Co. and the Kimble Glass Co., subsidiary corporations, at a cost of \$250,000. Herbert H. Green, archt.

CHICAGO—Lindstrom, Smith & Co., 1104 South Wabash Ave., has awarded the contract for the construction of a 1-story, 130 x 250-ft. factory for the manufacture of electrical specialties, on Lake St. and Kedzie Ave., to Jacob Rodatz, 209 South LaSalle St. Estimated cost, \$125,000.

Iowa

SIOUX CITY—The Sioux City Soap Co., 302 Grain Exch. Bldg., plans to build a soap factory.

Kansas

BAXTER SPRINGS—The Empire Development Co. plans to move its old Kentex Mill from Quapaw to a site which it has leased, southwest of here. The company is in the market for 1 compressor, 2 gas engines, 9 tables, rolls and screens. E. Malloccsay, supt.

TOPEKA—The city plans to construct a 10,000,000-gal. filtration plant. Estimated cost, \$100,000.

Kentucky

RIVERSIDE—The Standard Oil Co., 424-30 West Bloom St., Louisville, is having plans prepared for the construction of additions to its refinery at Riverside Station. The new plant will more than double the present capacity. Estimated cost, \$2,000,000.

Louisiana

MONROE—N. C. McGowan, Shreveport, plans to build a carbon black plant about 17 mi. from here. Estimated cost, \$250,000.

SHREVEPORT—R. S. Seamans, pres. of the Foursome Oil Co., plans to build a 5,000-bbl. refinery. Estimated cost, \$600,000.

Maine

PORTRLAND—The Amer. Can Co., B'way, New York City, has awarded the contract for the construction of a cannery, to the Turner Constr. Co., Tremont St., Boston, Mass. Chemical equipment, etc., will be installed in same.

PORTRLAND—A. S. Hinds, 20 West St., has awarded the contract for the construction of a 90 x 150-ft. laboratory, to Lorello & Piofano, 217 Stevens Ave. Chemical equipment will be installed in same. Estimated cost, \$150,000.

Maryland

BALTIMORE—A. H. Kuhlemann Co., 2961 Frederick Ave., has awarded the contract for the construction of a 3-story, 75 x 200-ft. factory for the manufacture of oleomargarine, on Frederick Ave., to W. L. and G. H. O'Shea, 29 B'way, New York City. Estimated cost, \$100,000.

Massachusetts

BOSTON—The Simbroco Co., 161 Devonshire St., has awarded the contract for the construction of a 1-story, 60 x 200-ft. factory at 270 Baker St., for the manufacture

of concrete products, to Simpson Bros. Co., 166 Devonshire St. Estimated cost, \$70,000.

New Jersey

NEWARK—The General Lead Batteries Co., 123 West 56th St., New York City, is having plans prepared for the construction of a 5-story factory on Lester Ave. and Chapel St. Estimated cost, \$150,000. Timmis & Chapman, 315 5th Ave., New York City, archts. and engrs.

NEW BRUNSWICK—George E. Maguire, pres. Trenton Porcelain Co., 803 East State St., will soon award the contract for the construction of a 2-story, 32 x 100-ft. porcelain plant. Estimated cost, \$20,000. W. A. Kleman, 1st Natl. Bank Bldg., archt.

New York

BUFFALO—The Buffalo Porcelain & Enameling Co., plans to construct a 2-story factory at 1927 Elmwood Ave. Estimated cost between \$20,000 and \$25,000.

ITHACA—C. D. Bostwick, comptroller, Cornell University, will receive bids until Feb. 24 for the construction, heating, sanitary and electric work at the Laboratory for Economic Investigation of Insects, New York State College of Agriculture, here.

UTICA—The Bowen Mfg. Co., manufacturer of paper and twine, 401 Columbia St., has awarded the contract for the construction of a 1-story, 102 x 225-ft. factory, to the Kimberly Constr. Co., Mayno Bldg. Estimated cost, \$29,000.

Ohio

CINCINNATI—The Jarecki Chemical Co., Broerman Ave., has awarded the contract for the construction of a 1-story, 120 x 350-ft. factory, to the Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost, \$300,000.

CLEVELAND—The Crucible Steel Forge Co., 6600 Grant Ave., has awarded the contract for the construction of a 1-story, 60 x 900-ft. rolling mill, annealing plant and machine shop on Grant Ave., to the Masters & Mullen Constr. Co., Electric Bldg. Estimated cost, \$500,000. Noted Jan. 7.

CLEVELAND—The Hydraulic Pressed Steel Co., Hydraulic Ave., has awarded the contract for remodelling the 1-story heat treating plant on Hydraulic Ave., to E. R. Russell, Sincere Bldg. Estimated cost, \$100,000.

LIMA—The Union Tank Line Co. has purchased a 130-acre site adjoining the property of the Solar Refinery and plans to build a large tank factory on same. Estimated cost, \$20,000,000.

Oklahoma

BEGGS—The Kre-Ko Refining Co., Bristol, is having plans prepared for the construction of a 1-story, 3,000-bbl. refinery, 1 mi. north of here. Estimated cost, \$400,000. John D'Arcey, genl. mgr. Foster & Gilmore, Tulsa, archts. and engrs.

South Carolina

CHARLESTON—The Commissioners of Pub. Wks., Water Dept., 14 George St., have awarded the contract for the construction of a filter plant, consisting of fourteen 1,000,000-gal. units, to the New York Continental Jewell Filtration Co., Flatiron Bldg., New York City. Estimated cost, \$125,000.

Texas

CLINTON—The Keen & Wolf Refining Co., 317 Beatty Bldg., Houston, is having plans prepared for the construction of a 1,000-bbl. oil refinery, including several buildings and 5 stills, near here. Estimated cost, \$300,000. A. Peterson, care of company, chief engr.

QUANNAH—The Four States Oil & Refining Co. plans to build a 1-story refinery, south of here. Estimated cost, \$400,000.

RANGER—The International Oil & Refining Co. plans to build a refinery. Estimated cost, \$300,000.

RANGER—The Olda-Clark Refining Co. plans to build a refinery. Estimated cost, \$250,000.

Wisconsin

CLEAR LAKE—W. L. Albana, archt., Endicott Bldg., St. Paul, Minn., will soon award the contract for the construction of a 2-story, 53 x 94-ft. high school, for the Bd. Educ. A septic tank will be installed in same. Estimated cost, \$60,000.

CUDAHY—The Federal Rubber Co., Packard Ave., is having plans prepared for the construction of three 6-story, 160 x 220-ft. factory buildings. G. B. Allen, 424 Jefferson Ave., Milwaukee, archt. and engr.

MILWAUKEE—The Westinghouse Lamp Co., 32nd and Center Sts., plans to construct two 3-story, 75 x 300-ft. additions to its factory on 32nd St.

Ontario

BELLEVILLE—The Bd. Educ. plans to build a 3-story Collegiate Institute. Chemical and physical laboratory equipment will be installed in same. Estimated cost, \$350,000. A. McGie, chmn.

LONDON—The city plans to build a sewage disposal plant to include an Imhoff tank or activated sludge system. Estimated cost, \$250,000.

TORONTO—The Bd. Educ. plans to construct 2- and 3-story additions to various schools in the city. Chemical and physical laboratory equipment will be installed in the high schools, collegiate and technical schools. Estimated cost, \$1,500,000. W. W. Pearse, 155 College St., Mgr.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CERAMIC SOCIETY will hold its annual meeting in Philadelphia, Pa., Feb. 23 to 26. Headquarters are at the Bellevue-Stratford Hotel.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive, in St. Louis. Headquarters will be at the Hotel Statler.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9 and 10. Headquarters will be at the Copley-Plaza Hotel.

THE AMERICAN ELECTROCHEMICAL SOCIETY, NEW YORK SECTION, will have a meeting on Feb. 27, the subject for which is "Electric Furnace Reducing Agents." Another meeting will be held on March 26, the subject of which is "Peace Uses for War Products."

THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York, Feb. 16 to 19.

THE AMERICAN PETROLEUM LEAGUE will hold a meeting in Chicago, March 26 to 29.

THE FARADAY SOCIETY (London) will hold a joint meeting, March 1, with the London Section of the Society of Chemical Industry to receive and discuss a report of Dr. T. Martin Lowry, and E. C. Hemmings on the "Setting of Salts and Other Crystalline Substances." Another meeting will be held March 23, at which there will be a general discussion on "Basic Slag From the Metallurgical and Agricultural Standpoints."

THE INSTITUTE OF METALS will hold its annual general meeting March 11 and 12 at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S. W. 1, London, England.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MATERIAL HANDLING MACHINERY MANUFACTURERS' ASSOCIATION will hold its convention at the Waldorf-Astoria Hotel, New York City, Feb. 26 and 27.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.